Authorized by the KING's Patent,

The Catholic - Organon, or,

UNIVERSAL SLIDING RULE

dicated to, and approved of by, the Right Ho
EORGE Lord *ANSON*, First Lord of the *Admiral*

CONSISTING of a Stock, which contains an Octagonal Slide, and 2
one about 30, the other 20 Inches, and 2 Thin Slides, with Brass Tongu
a Quadrant, in the Use of which, no Regard is had to the Horizon, but
The whole containing 86 Lines, exclusive of those on the Quadrant, ar
nac, of great Use in the Practice of Arithmetic, Geometry, Mensuratio
nometry, Navigation, Astronomy, Dialing, Statics, Algebra, Mechanic P
All the Branches of the Mathematics. Invented by JOHN SUXS
School-Master, in *Brook-street*, *Ratcliff-Cross*, near *LONDON*.

THE said Instrument is 12 Inches long, 1 Inch and 8 Tenths broad, a
eep. The Lines, *&c.* on the Instrument are, *viz.* The Meridian and Equ
roject a Mercators Chart. Dimensions of the Sides of Polygons inscribed in, circ
bout, and equal in Area to a Circle. Artificial Sine, and Tangent Rumbs. Square, Ro
nd Cube Line. Solid and Superficial Contents of Globes, and the Platonic Bodies. P
portion of Metals. Weight of the Globe, and Regular Solid Bodies of divers Metals,
he Diameter, or the Side what it may. Inches, Ale-Area and Diagonal from 1 Inch to
eet. Artificial Versed Sines, Tangents, and Sines. Dimensions of the Sides of the Platon
Bodies inscribed in, circumscribed about, and equal in Solidity to a Sphere. Segment of
Sphere, Circle, Cone, Parabolic-Spindle.

TO find the Ullage of any Cask, Lying or Standing, of great Use in Gauging and Measuring
The Periphery of Ellipsis's. An Astronomical Scale, containing a Perpetual Almanac, o
which may be found the Day of the Week, any Day in any Year. The Moon's Age, South
ng, Shining, Rising, Seting, and Distance at any Time from the Sun. The Sun
Place, Declination, Rising and Seting, Length of the Day and Night throughout the Yea
The Sun, and some principal Star's Right-Ascension. A Foot decimally divided, whi
hews the Principles of all Arithmetic, and by which the Logarithmetic Numbers, Sines a
Tangents may be found. A Plain Scale of Rumbs, Chords, Versed Sines. Sines, Secan
Tangents, Semi-Tangents, and Miles of Longitudes, by which may be found the Miles th
nswer to a Degree of Longitude in any Latitude. The most useful Canons in Astronom
f great Use in Navigation. The Solid Inches in a Pound Avoirdupois of divers Meta
nd Bodies, and the Weight of the same. Square and Round Divisors, and Gauge Point
f exceeding great Use in Gauging, Measuring, *&c.* Directions to find the Mean Diamet
f Casks of the most common Varieties, and to find new Gauge Points. Several Use
Matters relating to the Sun, Moon, Stars and Planets. The Principles of Algebra, Mech
ic Powers, Statics and Dialing. Superficial Contents of Cones, Pyramids, Cylinders. A
f Ellipsis's, Circles, *&c.* Customary and true Way of measuring Square and Round Tim
olidity of Cones, Pyramids, Cylinders, Spheroids, Parabolic-Spindles, and their Pro
o each other. Directions to find the Prime, Epact, Cycle of the Sun, Dominical-L
after in both Stiles. To find the Hour of the Night by the Moon's Shining on
nd also by the Star's Southing. A very easy Method to find a Distance,
readth at one Station, and many other Matters, which will appear in a Book
he Instrument, relating to Rope-making, finding the Tonage of Goods, Ship
Day's Works, either in Plain, or Mercators-Sailing by Inspection only. Mea
nd Artificers Work. In which Book are divers Methods of Arithmetic o
nents, all made easy to the meanest Capacity.

Conditions for Publishing the above Instrument by Subscr

EACH Subscriber to pay *Two Guineas* at his Subscribing, and *Three Guineas*
receiving the said Instrument compleat. 2. THE Subscription shall be closed
th Day of *June*, 1754. after which Time the said Instrument will not be Sold for l
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rk being in great Forwardness, a Specimen thereof is ready to be shewn to the Cu
s CARTWRIGHT's, facing the North Door of the *Royal* , where Subscriptio
and Receipts given for the Author; as also ENLEY's, S
Places a Description of th

ADVERTISEMENT.

By the King's Patent.

The CATHOLIC-ORGANON,

OR,

Universal Sliding FOOT-RULE.

WHICH consists of a Stock that contains an Octagonal Slide, and 2 Telescopes; one about 30, the other 20 Inches, and 2 thin Slides, each containing a Brass Tongue, that form a Quadrant, in the use of which, no regard is had to the Horizon, but Sun only. It contains 86 Lines, exclusive of those on the Quadrant, and Perpetual Almanac, which are of great use in the Practice of Arithmetic, Geometry, Mensuration, Gauging, Trigonometry, Navigation, Dialing, and all the Branches of the Mathematics; invented by *John Sussbeach*, School-Master in *Brook Street*, near *Ratcliff-Cross*, *London*: It's Breadth is 1.3 Inch. Depth .9. The Lines, &c. on the Instrument are, *viz.* The Meridian and Equinoctial, to project a Mercator's Chart, Dimensions of the Sides of Polygons inscrib'd in, circumscrib'd about, and equal in Area to a Circle. Artificial Sine, and Tangent Rumbs. Square, Root, and Cube Line: Solid and Superficial content of Globes, and the Platonic Bodies. Proportion of Metals, Weight of the Globe, and Solid Bodies of divers Metals, be the Diameter or Side what it may. Inches, Ale-Area, and Diagonal, from 1 Inch to 3 Feet. Artificial Versed Sines, Tangent and Sines. Dimensions of the Side of the Platonic Bodies, inscrib'd in, circumscrib'd about, and equal to a Sphere. Segment of a Sphere, Circle, Cone, Parabolic-Spindle. The Periphery of Ellipsis's. To find the Ullage of any Cask, lying or Standing. Of great use in Gauging, Measuring, &c. An Astronomical Scale, containing a perpetual Almanac, on which may be found the Day of the Week, any Day in any Year. The Moon's Age, Southing, Shining, Rising, Setting and Distance at any time from the Sun. The Sun's Place, Declination, Rising and Setting, length of the Day and Night throughout the Year. The Sun and some principal Stars right Ascension, a Foot decimally divided, which shews the Principals of all Arithmetic, and by which the Logarithmetic Numbers, Sines and Tangents may be found. A Plain Scale of Rumbs, Chords, Versed Sines, Sines, Secants, Tangents, Semi-Tangents, and Miles of Longitude; by which may be found the Miles that answer to a Degree of Longitude, in any Latitude. The most useful Canons in Astronomy, of great use in Navigation. The Solid Inches in a lb Avoirdupois of divers Metals and Bodies, and the weight of the same. Square and Round Divisors and Gauge Points, of exceeding great use in Gauging, Measuring, &c. Directions to find the mean Diameter of Casks of any Variety, and to find New Gauge Points. Several useful Matters relating to the Sun, Moon, Stars, and Planets. The Principles of Algebra, Mechanic Powers, and Dialing, Superficial content of Cones, Pyramids, Cylinders, Area of Ellipsis, Circles, &c. Customary and True way of measuring Square and Round Timber. Solidity of Cones, Pyramids, Cylinders, Spheroids, Parabolic-Spindles, and their Proportion to each other. Directions to find the Prime, Epact, Cycle of the Sun, Dominical Letter, and Easter in both Stiles. To find the Hour of the Night by the Moon's Shining on a Sun Dial, and also by the Star's Southing: &c. A very easy method to find a Distance, Altitude and Breadth at 1 Station, several useful matters relating to Rope-making, finding the Tonage of Goods, Ships, and working of Days works, either in Plain or Mercator's Sailing, by Inspection only. Measuring of Land, and Artificer's work, and many other Things, which will appear in this Book to be delivered with the Instrument, containing the Particulars of the same, and full Direction for the Use thereof, made easy to the meanest Capacity. *N. B.* The Author having received some Orders already, and as several Hands are imploy'd in making the Instruments, has open'd a Subscription at the following Places, *viz.* at JAMES HENLY's Stationer near *Ratcliff-Cross*, *London*,

and at his own House, where the said Instrument and Book of Instructions are to be seen, one Half to be paid on Subscribing, the other Half on Delivery of the same.

G. II. R.

GEORGE the Second, by the Grace of God, of *Great Britain*, *France* and *Ireland*, King, Defender of the Faith, &c. To all whom these presents shall come, Greeting.

Whereas our trusty and well beloved JOHN SUXSPEACH, of the Parish of Saint *Dunstan's*, *Stepney*, in our County of *Middlesex*, School-master, has by his Petition, humbly represented to us, that he has with much Labour and Expence, contrived and perfected an Instrument to be called

The Catholic-organon:

OR,

Universal Sliding Foot-Rule.

And which the Petitioner most humbly conceives, will be of great Service to many of our Subjects, who are desirous of being improv'd, instructed, or assisted in the Practice of Arithmetic, Geometry, Mensuration, Gauging, Trigonometry, Navigation, Dialing, Astronomy, and all other Branches of the Mathematics: and he being desirous of reaping the Fruits of his Labour and Expence, and of enjoying the Profit and Benefit that may arise from Making and Vending the same, without any other Person interfering in his just Property therein, which he cannot prevent, unless we are pleas'd to grant him our Royal Licence and Protection for that Purpose, and having therefore, most humbly pray'd us to grant him our Royal Licence and Protection for the sole Making and Vending the said Instrument; We being willing to to give Encouragement to all Arts and Inventions, that may be

For the PUBLIC GOOD,

are graciously pleas'd to condescend to his Request, and do therefore by these Presents, as far as may be agreeable to the Statute in that Case, made and provided, grant unto the said JOHN SUXSPEACH, his Executors, Administrators, and Assigns, our Royal Priviledge and Licence for the sole Making and Vending the said Instrument, for the Term of fourteen Years; to be computed from the Date hereof. Strictly forbiding and prohibiting all our Subjects, within our Kingdoms and Dominions, during the term of fourteen Years, from Making or Vending, directly or indirectly, the said Invention, or any part of the same attained unto, or by the said JOHN SUXSPEACH, nor any wise Counterfeit, Imitate, or Resemble the same, nor shall make or Cause to be made any Addition thereunto, or Subtraction from the same, without the Consent of the said JOHN SUXSPEACH, his Executors, Administrators, or Assigns, in Writing under his or their Hands and Seal, first had and obtain'd; in the behalf of such Pain and Penalty, as can or may be justly inflicted on such Offenders for their Contempt of this our Royal Command. And further, to be answerable to the said JOHN SUXSPEACH, his Executors, Administrators and Assigns, according to Law, for his and their Damages thereby occasion'd.

Witness ourself at *Westminster*, the 19th Day of February, in the 26th Year of our Reign.

THE

CATHOLIC-ORGANON

OR,

Universal Sliding Foot-Rule.

OF GREAT USE

In the Practice of Arithmetic, Geometry, Menſuration, Gauging, Trigonometry, Navigation, Aſtronomy, Dialing, Statics, Algebra, Mechanic Powers, and all the Branches of the Mathematics.

INVENTED

By JOHN SUXSPEACH, School-Maſter, near *Ratcliff-Croſs*.

LONDON:

Printed for the AUTHOR, in the Year 1753.

To the Right Honourable

GEORGE *Lord* ANSON,

Baron of *Soberton*, in the County of *Southampton*; One of His Majeſty's moſt Honourable *Privy-Council*, Admiral of the *Blue*, Vice-Admiral of GREAT-BRITAIN, Firſt Lord Commiſſioner of the *Admiralty*; Maſter and One of the Elder Brethren of the *Trinity-Houſe*;

THIS

Deſcription and *Explanation*

OF THE

CATHOLIC-ORGANON,

OR

Univerſal SLIDING FOOT-RULE,

Together with

The INSTRUMENT,

Serving greatly to improve and make eaſy the Knowledge and Application of PRACTICAL-MATHEMATICS; eſpecially of thoſe Branches, which relate to *Trade* and *Navigation*, *Geometry* and *Aſtronomy*, is moſt humbly inſcribed and preſented by

The Author.

PREFACE.

IN the Courſe of my Teaching, I found it neceſſary to have, if poſſible, an Inſtrument or Rule that might have on it ſuch Lines as commonly are not to be met with; and alſo ſome Canons and Directions for the ſake of eaſing the Memory. In order to which, I ſat about contriving a Sliding Rule, and after various Trials, have at leaſt compleated this; which will anſwer the ſeveral uſes of Scales, Sliding-Rules, Sectors, Foreſtaffs, Quadrants, Gauging-Rods, Teleſcopes &c. *Note*, This Inſtrument by Addition and Subtraction, performs all Operations that Numbers are capable of; tho' not always ſo very exact, but generally near enough for common uſe, for Multiplication and Diviſion are Compendiums

of

of Addition and Subtraction, and thoſe two Rules are the foundation of all Arithmetic; and that the Numbers on this Sliding Rule are ſuch Artificial ones, call'd Logarithms, that the Sum of any two of them is equal to the Product of the Natural ones they repreſent, and ſo is the Difference of any two equal to the Quotient. At the latter End of the Book in the Appendix, are divers other ways of working the Rules in Arithmetic, as by the Line of equal Parts, Sector, Logarithms and Sinical Quadrant, by which laſt Inſtrument, a very expeditious Method is ſhewn of working Day's works, either in Plain or Mercator's Sailing by inſpection only; as alſo ſeveral uſeful matters relating to Rope-making, finding the Tonage of Goods, Ships, Artificer's Work.

As this Inſtrument was deſign'd for my own uſe, I had no thought of making it publick, till adviſed thereto, and to take this method to ſecure it to myſelf, in caſe it meet with Approbation; have therefore

fore comply'd for the ſake of thoſe, whoſe buſineſs or delight lay in theſe Studies, to whoſe Candour it is humbly recommended by

The AUTHOR

With whom Youth may Board, and be Taught by him, and proper Aſſiſtants, *Writing*, *Arithmetic*, *Merchant's Accounts*, *Engliſh*, *Latin*, *Greek*, *French*, the uſe of the *Globes*, and of this *Inſtrument* in all it's Branches.

A TABLE of the Principal Matters contain'd in this Book.

Co-

Globe,

Inches,

ERRATA.

Page	Line	for	read
Pref.	1	11	leaſt	laſt
Tab.	4	16	Axiſs	Axis
of	7	10	New in	New, in
Con-	8	34		
tents.		36	its Side	Side
	11	25	Tatraedron	Tetraedron
Book	11	33	to 60's.	two 60's.
	15	7	.4714 Anſ.	4714. Anſ.
	20	29	Delination	Declination
	21	16	on 3d and 5th	on 5th
	27	15	8.8	8
	31	6	O riſing	⊙ riſing
	43	1	Gauge	Gauge Points
		13	, Depth	: Depth
	55	1	Fix. ✱, &c.	Fix ✱ Po Ec 25920
	55	2	*Explan.* The &c.	*Expl.* The fixed Stars move on the Poles of the Ecliptic in 25920 Years
	55	19	— =	— *a* =
	56	12	× *a* —	× — *a*
		13	to — *a a*	to *a a*
		15	to *a a*	to — *a a*
		32	+ *a b*	+ 2 *ab*
	57	6	+ 99	+ 9
	61	32	⊕	●
	62	2,9		
		13,20	19	24
	66	37	on : 1 □	: 1 on the □
	67	16	as is	as it is
	69	25	Circle	1ſt Circle
		28	Or	Operation
	71	35	Year	,
	74	4	= Age	= ☾'s Age
	75	24	Moon	Moons
	76	33	time	at that time
	85	19	2 Minutes, &c.	a qu. of a Min.
	100	5	work	works
	102	23	Courſe	Courſe ;
	105	6	ſays	ſay
	105	29	of the	of

THE DESCRIPTION OF THE CATHOLIC-ORGANON OR, Univerſal Sliding Foot Rule.

IT'S Breadth is 1 Inch. 8, Depth. 9 Tenths, which conſiſts of a Stock that contains an Octagonal Slide; in the Inſide of which is a braſs Drawer containing part of a Teleſcope, ſo contriv'd, that when the Inſtrument is in the Caſe (the End having an Object Glaſs) the ſame forms a compleat Teleſcope, about 30 Inches in Length. The End of this Drawer contains a Plummet; uſed in Time of Obſervation. On each Side of the Inſtrument is a thin Slide, each containing a braſs Tongue, that form a Quadrant; in the uſe of which, no regard is had to the Horizon, but Sun only. At one End of the Octagonal Slide is a braſs Head, containing 2 ſmall Slides, or Slips of Braſs; in the midſt of each, is a Piece of dark Glaſs; to be uſed in taking an Obſervation by the Sun; under thoſe dark Glaſſes (in the braſs head) is an Object Glaſs, which, with the braſs Drawer, makes another Teleſcope; about 20 Inches in Length. In the braſs Piece at the End of the Caſe are 2 ſmall Screws, whoſe uſe are to keep the braſs Tongues together, and hold the Plummet.

The ſaid Inſtrument contains 86 Lines, excluſive of thoſe on the Quadrant and perpetual Almanac.

The Lines on the Inſtrument are as follow:

N°. *On the firſt Face of the Stock, mark'd* A, *are* 12 *Lines, viz.*

1 A Meridian Line.

2 A Line of Equal Parts, or Equinoctial.

3 If the Diameter of a Circle is 1, the Side of the Regular Polygons that may be inſcrib'd in that Circle is, &c. and a Line of Tangent Rumbs.

4 If the Diameter of a Circle is 1, the Side of the Regular Polygons that may be circumſcrib'd about that Circle is, &c.

5 If the Diameter of a Circle is 1, the Side of the Regular Polygons equal to the Area of the Circle is, &c. and a Line of Sine Rumbs.

6 A Line of Artificial Numbers, or Squares.

7 A Line of Artificial Numbers, or Cubes.

8 Solid Content of the 5 Bodies, if the Side is 1, and Proportion of Metals, if Shape and Weight are the ſame.

9 Globe Diameter 1 Inch, and Tetraedron Side 1 Inch.

10 Octaedron and Hexaedron Side 1 Inch.

11 Icoſaedron Side 1 Inch.

12 Dodecaedron Side 1 Inch, their Weight in Pounds Avoirdupois of divers Metals.

On the ſecond Face of the Stock, mark'd B, *are* 11 *Lines, viz.*

13 Inches.

14 Ale Area.

15 Beer Diagonal.

16 Artificial Verſed Sines.

17 Artificial Tangents.

18 Artificial Sines.

19 Artificial Line of Numbers, or Squares, and Polygons Area, if the Side is 1.

20 Superficial Content of the 5 Bodies, and a ſmall Scale of Chords.

21 If the Diameter of a Sphere is 1, the Side of the Platonic Bodies that may be inſcrib'd in that Sphere is, &c. and a ſmall Scale of Chords.

22 If the Diameter of a Sphere is 1, the Side of the Platonic Bodies that may be circumſcrib'd about that Sphere is, &c. and a Line of Equal Parts.

23 If the Diameter of a Sphere is 1, the Side of the Platonic Bodies that are equal in Solidity to that Sphere is, &c. and a Line of Equal Parts.

Octagonal Slide, mark'd C, *contains* 15 *Lines, viz.*

24 A Line of Artificial Numbers or Squares, and Proportion of Metals, if Shape and Weight are the ſame.

25 Segment of a Sphere.

26 Segment of a Circle.

27 Segmen

27 Segment of a Cone.
28 Segment of a Parabolic Spindle.
29 Artificial Tangent Line.
30 Periphery of an Ellipſis.
31 Artificial Numbers or Root Line, on which are placed ſeveral Gauge Points,
32 Spheroid Lying.
33 Spheroid Standing.
34 Artificial Sines.
35 Second Form Lying.
36 Second Form Standing.
37 Third Form Lying.
38 Third Form Standing.

On the Thin Slide, mark'd D, *and Edge of the Stock, are a Perpetual Almanac, and an Aſtronomical Scale, containing* 8 *Lines, beſides the Almanac, viz.*

39 Moon's Age.
40 Moon's Southing.
41 Moon's Shining.
42 Sun's Place.
43 Calendar, and Sun's Riſing.
44 Sun's Declination.
45 Sun's Right Aſcenſion.
46 Star's Right Aſcenſion.

On the Back of that Slide mark'd E, *and on the Bottom Edge of the Stock, are* 6 *Lines, viz.*

47 A Line of Inches,
48 Ale Area.
49 Beer Diagonal.
50 A Line of Artificial Numbers, or Squares,
51, 52 } A Foot Decimally divided, named Log.

On the Thin Slide, mark'd F, *and Edges of the Stock, is a plain Scale containing* 6 *Lines, viz.*

53 A Line of Rumbs, and Miles of Longitude, and to find the Diameter of a Circle having the Chord and Verſed Sine.
54 Several Chords.
55 Verſed Sines and Equal Parts.
56 Sines and Secants.
57 Tangents.
58 Semi-Tangents.

On the Back of that Slide, mark'd G, *are* 4 *Lines, viz.*

59 A Line of very uſeful Canons in Aſtronomy.
60 Beer or Ale Diagonal.
61 Ale Area.
62 Inches.

The Writing on the Inſide the Stock, mark'd H, *conſiſts of* 14 *Lines.*

63, 64, 65, Part 66 } The Solid Inches in a Pound Avoirdupois of divers Metals, *&c.* and their Gauge Points or Roots.

Part 66, All 67, All 68, Part 69 } Square and Round Diviſors, and Gauge Points, and Methods to find the Mean Diameter of the Varieties of Caſks.

Part 69, All 70, Part 71 } The Weight of a Cubic Inch, in Ounces Avoirdupois of divers Metals, *&c.*

Part 71, All 72, Part 73 } The Weight of a Cubic Foot, in Pounds Avoirdupois.

Part 73, Part 74 } The Principles of Mechanic Powers.

Part 74, Part 75 } Several uſeful Matters relating to the Sun, Moon, Stars, and Planets, *&c.*

Part 75, All 76 } The Principles of Algebra.

The Writing under the Thin Slides, and Firſt of that Side mark'd I, *conſiſts of* 5 *Lines.*

77 To find the Area of a Circle. The Solid and Superficial Content of a Globe. Circumference of a Circle. Superficial Content of a Cone. Side of a Square inſcrib'd in a Circle. Side of a Square equal in Area to the Area of a Circle.

78 Superficial Content of a Cylinder. Area of an Ellipſis. To find the Square of the Diameter of a Circle. Cuſtomary Way of meaſuring Square and Round Timber. Proportion of Cones to Cylinders or Parallelepipedons. Proportion of Square and Triangular Pyramids and Cylinders to Cubes or Parallelepipedons. Spheres to Cubes and Cylinders.

79 Proportion

79 Proportion of Parabolic and Hyperbolic Conoids, and Parabolic Spindles and Spheroids to Cylinders or Parallelepipedons. To find the Perpendicular of a Triangle, Proportion of Circles, Spheres, Area of Circles and Parabola's.

80 Contains the Principal Canon in Trigonometry. To find the Prime. Epact, in Old Style and New. Cycle of the Sun.

81 To find the Dominical Letter, and Easter Limit.

The Writing under the other Thin Slide, which Side is mark'd K, *consists of five Lines. viz.*

82 To find Easter Day in both Styles, the Distance of the Moon from the Sun, the Day of the Month of New Moon, and to find the Moon's Age.

83, 84 To find the Moon's Southing, Shining, Rising, and Setting. The Time of Stars Southing, and to find the Hour on a Sun Dial by the Moon's shining.

85, 86 The Principles of Dialing.

The Explanation of divers Characters and Marks made use of in the following Work, in order to shorten the Same.

= Equal, or Sign of Equality as $3 + 2 = 5$, *i. e.* 3 and 2 are Equal to 5.

\+ Signifies Plus, or more. The sign of Addition as $3 + 2$ that is, 3 and 2, or 3 plus 2, $= 5$.

— Signifies minus, or Less; as $3 - 2$, that is, 3 wanting 2, or 3 minus 2, $= 1$.

× Signifies Multiply'd by; as 3×2, that is, 3 multiply'd by 2, $= 6$.

÷ Signifies Divided by; as $6 \div 2$, or $\frac{6}{2}$ that is, 6 divided by 2, $= 3$.

: Signifies, is to; or, to

: : So is, or so. The Signs of Proportion.

Exam. As 2 : 3 : : 6 : 9; that is, As 2 is to 3, so is 6 to 9.

or thus
As □ 2 —— 6
□ 3 —— 9 Ans.

Explan. As 2, on the Square Line, is to 3 on the Square Line; so is 6 on the Square Line, to 9 on the Square Line.

∠ Angle.

∠s Angles.

⊥ Perpendicular.

Z Sum.

X Difference.

Co-Complement.

C. S Co-Sine, or Sine Complement.

C. T Co-Tangent, or Tangent Complement.

Sec.

Sec Secant.
⊙ Involved, or multiply'd into itſelf, as ⊙2, is the 2d involved.
ɯ Evolved or the Extraction of the Root, as ɯ3, is the 3d Evolved or extracted.
⊏ Greater.
⊏ Leſs.
R Radius.
$\sqrt{_2}$ Sign of the Square Root as $\sqrt{_2}$, 81 = 9 the Root
$\sqrt{_3}$ Sign of the Cube Root as $\sqrt{_3}$, 27 = 3 the Root.
Expl. Explanation.
Exam. Example.
∴ Therefore.

Signs.

Northern	Southern
♈ Aries.	♎ Libra.
♉ Taurus.	♏ Scorpio.
♊ Gemini.	♐ Sagittarius.
♋ Cancer.	♑ Capricornus.
♌ Leo.	♒ Aquarius.
♍ Virgo.	♓ Piſces.

Planets and the Metals they ſtand for.

☉ Sol, Sun, Gold.	♃ Jupiter, Tin.
☾ Luna, Moon, Silver.	♀ Venus, Copper.
♂ Mars, Iron.	♄ Saturn, Lead.
☿ Mercury, Quickſilver.	⊖ Earth.

Alſo the Planets are put for the Days of the Week, as Sol, Sunday, or the 1ſt Day. Luna Monday, or the 2d Day. Mars, Tueſday, or the 3d Day. Mercury, Wedneſday, or the 4th Day. Jupiter, Thurſday, or 5th Day. Venus, Friday, or the 6th Day. Saturn, Saturday, or the 7th Day.

Aſpects, &c.

☌ Conjunction, that is, when the Sun and Moon, &c. are in 1 Sign and Degree.
SS Semi Sextile, when they are 1 Sign, or 30 Degrees aſunder.
⚹ Sextile, 2 Signs, or 60 Degrees.
⚺ Quintile, 72 Degrees.
□ Quartile, 3 Signs, or 90 Degrees.
△ Trine, 4 Signs, or 120 Degrees.
☍ Oppoſition, 6 Signs, or 180 Degrees.
☊ Dragon's Head, ☋ Dragon's Tail.

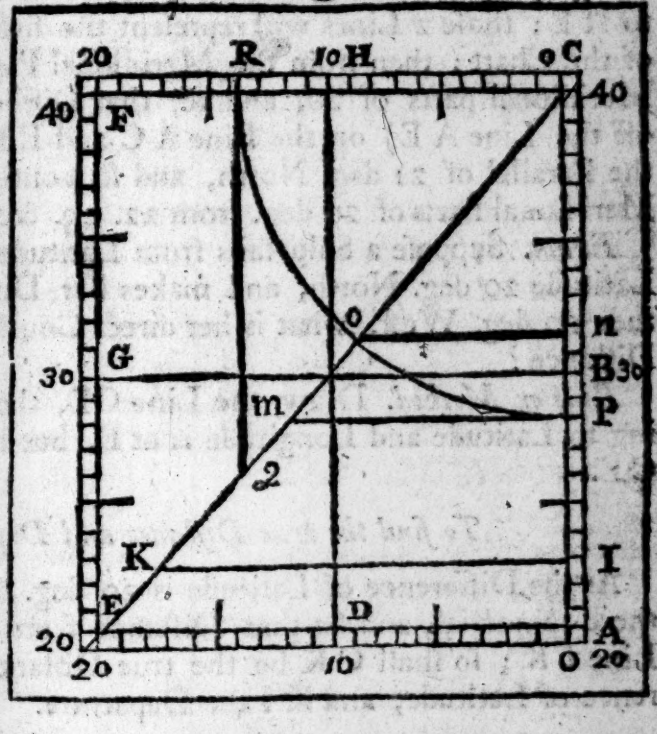
Iſt. Face of the Stock mark'd *A*.

THE uſe of the 1ſt and 2d Line, named Meridian and Equinoctial; is to project a Mercator's Chart, on which to keep a Ship's Reckoning at Sea.

Exam. To make a Chart, which ſhall contain from 20 Degrees North Latitude, and 0 Degrees Longitude, to 40 Degrees North Latitude, and 20 Degrees Weſt Longitude.

The Method.

Fig. 1



Firſt Draw the Lines AC and AE at Right Angles; then take the Extent from 20 to 30° off the Meridian Line, and ſet that from A to B; alſo take the Extent from 30 to 40°, and ſet that from B to C, ſo is AC the Meridional Difference of Latitude. Then to ſet off the Difference of Longitude, take the Extent from 0 Degrees to 10 off the Equal Parts, or Equinoctial Line, which ſtands under the Meridian Line, and ſet that from A to D, and alſo from 10 to 20 and ſet that from D to E; draw the Lines EF, FC, GB, HD. The ſingle Degrees are drawn after the ſame Manner.

To enlarge or diminiſh the Meridian Line, by the Inſtrument.

Suppoſe, I'd have 10 Degrees of Longitude = 1 Inch. The Beginning of the Chart according to the Latitude is at 20, then to ſet off the Meridional Difference of Latitude from 20 deg. to 30, take the Extent from 20 to 30 off the Meridian Line and meaſure that on the Equinoctial, which will be found to be 11 deg. 3 min. or 11.05 deg. on that Line; then as the Line of Inches is Decimally divided, take ℞ 1.105 Inch, which

which is equal to 11 deg. 3 min. and ſet that from 20 Degrees of Latitude to 30; then take the Extent from 30 to 40, off the Meridian Line, and meaſure that on the Equinoctial, which is 12 deg. 23 min. therefore take 1,223 Inch. and ſet that from 30 deg. to 40, &c.

N. B. The Degrees on the Equinoctial are all equal.

To project a Chart by the Table of Meridional Parts.

Method, Draw the Line A E, which repreſents the Parallel of Latitude for 20 Degrees North, divide the ſame into 20 Equal Parts of any Diſtance; as, ſuppoſe each Diſtance, or Part, be an Inch, half an Inch, &c. they'll repreſent the 20 Degrees of Longitude; then draw the Lines A C and E F, perpendicular to A E; thoſe 2 Lines will repreſent the firſt and laſt Meridian of the Chart; then from the Meridional Parts of 21, take the Meridional parts of 20, and ſet that Difference (being taken off the Line A E) on the Line A C and E F, which repreſents the Parallel of 21 deg. North, and ſo continue ſubtracting the Meridional Parts of 20 deg. from 22. 23. &c.

Exam. Suppoſe a Ship ſails from Latitude 40 deg. North to Latitude 20 deg. North, and makes her Difference of Longitude 20 deg. Weſt, what is her direct Courſe, Departure, and Diſtance?

Rule or Method. Draw the Line C E, then the Ship according to Latitude and Longitude is at E, but her Diſtance is not C E.

To find the true Diſtance and Departure.

As the Difference of Latitude is 20 deg. take 20 Degrees off the Equinoctial, and ſet that Diſtance from C to I; draw the Line I K; ſo ſhall C K be the true Diſtance, C I the Difference of Latitude, and K I the Departure.

To find the Courſe.

With the Chord of 60, deſcribe the Arch O P; that meaſur'd on the Chords, is the Chord of the Courſe; O N meaſur'd on the Sines, is the Sine of the Courſe; M P meaſured on the Tangents, is the Tangent of the Courſe.

N C, Q R, C M, C Q } is { Co-Sine of the Courſe. Co-Tangent. Secant. Co-Secant.

C O = C P = C R = Radius, or Semidiameter, = Chord of 60, Sine 90, Tangent 45.

If

If the Diameter of a Circle is 1, then the Side of the regular Polygons inſcrib'd in that Circle, circumſcrib'd about that Circle, and equal in Area to that Circles Area is, as in

The TABLE.

Diameter of a Circle 1, the Side of a Regular		That may be inſcrib'd in the O.	Circumſcrib'd about the O.	Equal to the O.
Side.				
3	Trigon.	.86603	1.73205	1.34704
4	Tetragon.	.70711	1.	.88623
5	Pentagon.	.58778	.72654	.67578
6	Hexagon.	.5	.57735	.54992
7	Heptagon.	.43392	.48160	.465
8	Octagon.	.38268	.41421	.40393
9	Nonagon.	.34202	.36397	.35651
10	Decagon.	.30901	.32491	.31955

Note, theſe Numbers ſtand over the Line of Squares, that is, where the Number for the Trigon .866 ſhould be, there ſtands 3, which ſignifies a Trigon, and ſo of the reſt; and that the Dots at the left hand of the Figures ſignify the Numbers under them are Fractions; that is .3 = Trigon is .866.

Exam. To find the Side of a Trigon, that may be inſcrib'd in, circumſcrib'd about, and equal in Area to a Circle, whoſe Diameter is 9.

Rule, As 1 on the Square Line on the Slide, is to the Tabular Number on the Square Line on the Stock (which ſtands under 3, ſignifying Trigon) ſo is the Diameter of the Circle on the Slide, to the Anſwer on the Stock.

Operat. 3, 6, 24 } 3 .866 —— 7.794 Inſd. { 4, 6, 24 } 3 1.732 —— 15.588 Cird.
Line, As 1 —— 9 As 1 —— 9

Line, 5, 6, 24 } 3 1.347 —— 12.123 Equal.
As 1 —— 9

Explan. As 1 on the 24 Line : .866 the Tabular Number for Trigon on the 6th Line, or to figure 3, ſignifying Trigon inſcrib'd on the 3 Line : : 9 the Diameter on the 24 Line: Side of the Trigon on the 6th Line, that may be inſcrib'd in a Circle, whoſe Diameter is 9 : and ſo for circumſcrib'd and equal, &c.

Anſ. The Side Inſcrib'd = 7.794
Circumſcrib'd = 15.588
Equal = 12.123

Exam. The Circumference of a Circle given, to find the ſide

of a Trigon, that may be inſcrib'd in, circumſcrib'd about, and equal in Area to that Circle.

Rule, Find the Diameter, and work as before.

The Side of any regular Polygon given, to find the Diameter, or Circumference of it's inſcrib'd, circumſcrib'd, and equal Circle.

Exam. Let the Side of a Trigon be 1.

Firſt for the Diameter.

Rule, As the Tabular Number inſcrib'd, circumſcrib'd, Equal (or Figure 3, which ſtands for Trigon) on the Square Line, on the Stock : : 1 on the Slide, on the Square : : given Side of the Polygon, on the Stock : Diameter of the circumſcrib'd, inſcrib'd, and equal Circle, and ſo for any other regular Polygon.

Ope. 3 6 24 } As 3 .866—1 / 1—1.154 Cir. { 4 6 24 } 3 1.73—1 / 1—.577 Inſ.

Ope. 5 6 24 } 3 / 1.347—1 / 1—.742 eq. The inſcrib'd Circles Diameter = .577
Circumſcrib'd D°.—— —— 1.154
Equal D°.—— —— .742

2d *For the Circumference.*

Rule, As the Tabular Number inſcrib'd on the Square, : Circumference on the Square : : Side of the Polygon on the Square : Circumference of the O, that will circumſcribe that Polygon, &c.

N. B. The Circumference of a Circle, Diameter 1; is 3.14 159. See the 77th Line.

Ope. 3 6 24 } 3 / As .866—1 / : 3.14—3.62 Cir. { 4 6 24 } 3 / 1.73——1 / :3.141——1.81 Inſ.

Line, 5 6 24 } 3 / 1.347——1 / :3.141——2.33
The Circumference of the Inſcrib'd Circle = 1.81
Circumſcrib'd Circle = 3.62
Equal Circle = 2.33

The Side of any regular Polygon given, to find the Side of any other regular Polygon equal thereto.

Exam. If the Side of a Trigon is 10, what's the Side of a Tetragon, whoſe Area is equal to the Trigon's Area?

Rule, As the Tabular Number under equal, or 3, ſignifying Trigon : Side on the Square, : : the Tabular Number, for Tetragon or 4 ſignifying Tetragon, : Anſwer.

Operat. 5 6 24 } 3 / As 1.34—.886 / 10—6.579 } or { 5 / 24 } .4—3 As / Anſ. 6.579—10

Anſwer, The Side of the Trigon, is 6.579, whoſe Area is equal to the Area of a Trigon whoſe Side is 10.

The Side of a Trigon given, to find the L.

Exam.

Exam. If the Side of a Trigon be 10, what's the Perpendicular?

Rule, As 1 on the Square :. 86603 on the Square : : Side of the Trigon on the Square : Anſwer.

Operat. { 6 } :. 86603——8.6603 Anſ.
Line, { 24 } As 1——10

or, The Square of the Side, — Square of $\frac{1}{2}$ the Side, = the Square of the Perpendicular.

or, 1ſt, See the uſe of the 18th Line then take this

Rule, As Sine 90 : Side on the Square : : Sine 60 : ⊥

Operat. { 18 } 90——60
Line, { 24 } 10——8.66 Anſ.

To find the Diagonal of a Tetragon or Square.

Exam. What's the Diagonal of a Tetragon, whoſe Side is 10.

Rule, As Sine 45 : Side on the Square : : Sine 90, : Diagonal.

Operat. { 18 } 45——90
Line, { 24 } 10——14.14 Anſ.

or, The Square Root of twice the Square of the Side = Anſ.

Operat. $10 \times 10 \times 2 = 200$ and $\sqrt{2}$, = 14.14

To find the Trigon — Tetragon — Pentagon — Hexagon — Heptagon — Octagon — Nonagon — and Decagon—al natural Chord of any Circle, whoſe Diameter is given.

Anſ. The Trigonal, Tetragonal, &c. natural Chord of a Circle, = Side of its inſcrib'd Trigon, Tetragon, &c.

To inſcribe the Polygons.

Exam. Inſcribe a Trigon, &c. in a Circle whoſe Diameter is 1.

Rule, Deſcribe a Circle whoſe Diameter is 1, then take the inſcrib'd Number for a Trigon, &c. and move the Compaſſes about the Periphery, draw the Lines that compoſe the Figure, and it is done, and ſo for any other.

or, With the Chord of 60 deſcribe a Circle, and as the Chord for a Trigon is 120 = to 60's or $\frac{1}{3}$ of 360, Take the Chord of 60, and ſet that about the Periphery; 2 of thoſe 60's are = to 1 Side; and for a Tetragon, take the Chord of 90; for an Hexagon the Chord of $\frac{1}{6}$ of 360 &c.

N. B. At the End of the 3d and 5th Line, are Tangent and Sine Rumbs; their uſe are ſhewn in the 18th Line.

To find any Chord in a Circle, that croſſes the Diameter at right Angles in any Point aſſign'd.

Exam. If the Semi-Diameter of a Circle is 6.5 what's the Length of the Chord that croſſes the Diameter at right ∠'s, at the Diſtance of 4 Inches from 1 end of the Diameter?

Rule, Find the Difference between the Semi-Diameter and part cut off, then from the Square of the Semi-Diameter, ſubtract the Square of the Remainder, the Square Root of the Difference is $\frac{1}{2}$ the Chord of that Arch.

Operat. 6 . 5 □d. — 2 . 5 □ d. = 36; the $\sqrt{\ }$ = 6 and x d. 2 = 12 Chord Q E I.

Or by Trigonometry. *Line*, { 6 } 6.5——2.5
{ 34 } 9 0——22. 37 fere

And 90—22.37=67.23

Then Say. *Line*, { 18 } 90 ——67 . 23
{ 24 } 6.5—— 6 equal $\frac{1}{2}$ the Chord.

6th Line.

NUMERATION on the ſliding Rule, or the Method to know the Number, or Value of any particular Space on the Square, Root, or Cube Line.

Rule, Admit I call the firſt one on the Square Line at the beginning (that is towards the Left hand) One; then, the one in the middle is 10, and the 1 at the end, on the Right hand, is 100. If I call the firſt One, 10; then the 2d One, is 100; the 3d One is 1000. If the firſt One repreſents 1, the 2 following repreſents 2, the 3, 3; and if the firſt one repreſent 10, then the 2 following repreſents 20; the 3, 30. &c. If the firſt one repreſent 1, the 1ſt grand Diviſion next the 1 is .1 or one tenth part, ſo that the Extent from 1 at the beginning, to the firſt grand Diviſion is = to 1.1; that is, 1, and 1 tenth part of 1; and the extent from the 1 at the Beginning, to 2 of thoſe grand Diviſions, = to 1.2 that is, 1 and 2 tenth parts of one.

If the one at the beginning repreſents 10, then the 1ſt grand Diviſion repreſents 1, and the extent from the 1 at the beginning to the 1ſt grand Diviſion = to 11, &c.

To find the Number 12 *on the Square Line.*

Rule, If the 1ſt one is counted one, then the 2d one in the Middle is 10, and the 2 grand Diviſions after that Middle one, repreſents 12. but if the firſt one is counted 10; then, the extent from that firſt one, to the next 2 grand Diviſions = to 12, &c.

To find the Number 122.

Rule, If the 1ſt one is counted 100, the 2d grand Diviſion repreſents 20, and the 1ſt ſmall Diviſion repreſents 2, becauſe from 20 to 30 is Divided into 5 Parts, and one of thoſe 5 parts is counted 2, by reaſon, that from every grand Diviſion to the next is ſuppoſed to be Divided into 10 Parts. So that the Diſtance from the one at the beginning, to the 1ſt ſmall ſtroke

next

next the 2d grand Diviſion after the 1ſt one aforeſaid, is the place of 122.

To find the Number 123.

Having found the Number 122; then the Diſtance from 1 at the beginning, to the middle between 122 and 124, is the place of 123.

Examples in Multiplication according to the Table.

What's the Product of the Numbers from 1 to 12, Multiplied by 2, 3, 4, &c.

Rule, As 1 on the 6th Line: Multiplier on the 24th Line :: Multiplicand on the 6th Line, : Anſwer on the 24th Line, and ſo for the reſt.

Operat. Line, { 6 / 24 } As 1——2——3——4——5 is to 2——4;—6;—8;—10. &c.

Operat. Line, { 6 / 24 } As 1——2——3——4——5 is to 3——6;—9;—12;—15. &c.

Expl. Twice 1 is 2. twice 2 is 4. twice 3 is 6. twice 4 is 8. twice 5 is 10. 3 times 1 is 3. 3 times 2 is 6. 3 times 3 is 9. 3 times 4 is 12. and 3 times 5 is 15. &c.

Example in Diviſion.

What's the Quotient of 18 ÷ by 3?

Rule, As the Diviſor on the 6th Line, : an unit, or 1, on the 24th Line : : Dividend to the Anſwer.

Operat. Line, { 6 / 24 } As 3——18 / 1——6 Anſ.

Examples in the Rule of Three.

If 6 Yards coſt 18 s. what coſt 9 Yards?

Rule, As the Quantity given on the 6th Line, : price given on the 24th Line : : the Quantity whoſe price is requir'd : Anſwer.

Operat. Line, { 6 / 24 } As 6——9 / 18——27 Anſ.

Examp. 2. If 6 Yards coſt 18 s. 6 d. what coſt 9 Yards?

Operat. Line, { 6 / 24 } 6——9 / 18.5——27.75 or 27.9 s. d.

Example in the Square Root.

What's the Root of 9?

Rule, Set 1 on the Square Line, to 1 on the Root Line, then under 9 on the Square Line, ſtands 3 on the Root.

Operat.

Operat. { 6 } 1——9
Line, { 31 } 1——3 Anſ.

or, Take the Middle between 1 and 9 on the Square Line, with Compaſſes, that middle is the Root.

Operat. Line, 6. . . . .1——3 Anſ.——9

Example in the Cube Root.

What's the Cube Root of 27?

Rule, Set Unit on the Cube Line, to Unit on the Root Line; then againſt 27 on the Cube Line, ſtands 3 on the Root Line.

Operat. { 31 } 1——3 Anſ.
Line, { 7 } 1——27

or, Take the $\frac{1}{3}$ Part between 1 and 27 with Compaſſes, on the Square, or Cube Line, that extent is the Anſwer.

Operat. { 6 or 7 } 1——3 Anſ.——9——27
Line,

7 Line. Cube.

Exam. If a Globe of 4 Inches Diameter weighs 9 lb. what will a Globe of 8 Inches Diameter weigh?

Rule, As the Diameter on the Root Line : the Weight on the Cube Line : : Diameter on the Root : Weight on the Cube.

Operat. { 31 } As 4——8
Line, { 7 } 9——72 Anſ.

8 Line.

Solid Content of the 5 regular, or Platonic Bodies, and Globe, if the Side or Diameter is one.

TOGHID

Expl. T ſtands for Tetraedron, O Octaedron, G for Globe, H Hexaedron, I Icoſaedron, D Dodecaedren. *N. B.* If the Side of each Body is 1, then the Solidity as in the Table.

The uſe of the Table.

The TABLE.	
T	.117851
O	.471404
G	.5236
H	1.
I	2.181695
D	7.663119

Exam. If the Side of an Octaedron be 10, what is its Solidity?

Rule, As 1 on the 31ſt Line : the Tabular Number for the Octaedron =.4714, on the 7th Line, or O on the 8th Line : : Side : Anſ.

Operat.

Operat. { 31 } As 1 ——10 } or { 31 } 1 ——10
Line, { 7 } .4714—4714 } { 8 } O——4714

or, As 1 on the 6th Line : the Tabular Number on the 24th Line : : the Cube of the Side, on the 6th Line : Anſwer on the 24th Line.

Operat. { 6 } 1——1000
Line, { 24 } .4714——4714 Anſwer.

And ſo for the other Bodies.

Examp. If the Solidity of an Octaedron is 3.7712, What's the Solidity of a Dodecaedron, whoſe ſide is the ſame as the Octaedron's ?

N. B. as theſe Bodies Solidity are meaſur'd on the Cube, take this.

Rule, Bring any Figure, as ſuppoſe 1, either on the Square, or Root, on the Slide, it matters not, but ſuppoſe on the Square, to ſtand againſt the Octaedron under the Cube ; then againſt the Dodecaedron, under the Cube, make a Dot on the Slide ; Let the 1 on the Slide, ſtand againſt the Solidity of the Octaedron on the Cube, and againſt the Dot on the Slide, is the Solidity of the Dodecaedron on the Cube.

Operat. { 24 } 1——6● Line { 24 } 1——●
Line, { 8 } O——D { 7 } 3.7712—61.3 Anſ.

Ex. If the Side of an Octaedron be 2, and its Solidity 3.7712 What's the Side of a Dodecaedron equal in Solidity thereto ?

Note, As the Dodecaedron's Side muſt be leſs than the Octaedron's, this is the

Rule, As the Tabular Number for Dodecaedron on the Cube, or D, on the 8th Line : 2, the Side on the Root Line : : Tabular Number for Octaedron on the Cube, or O, on the 8th Line : Side of the Dodecaedron.

Operat. Anſ. .787 is to 2
ſo is .471 — As 7.663 { 31 / 7 / 8 } Line
O——D

Obſerve, in this Operation, the Slide is too ſhort to reach the Tabular Number for the Octaedron, or O ; therefore in this Caſe and all ſuch, mind what Stroke the firſt one on the Root cuts, which here is .96, on the Cube ; therefore, bring the one at the end of the Root Line, to ſtand againſt the .96 and againſt the O, on the 8th Line, or Tabular Number for Octaedron on the Cube, ſtands .787 on the Root ; = Side of the Dodecaedron required.

N. B. Near the End, under the Cube Line, is Proportion of Metals, if the Shape (and Weight) are the ſame, mark'd with theſe Characters. ♃ ♂ ♀ ☾ ♄ ☿ ☉, which are explain'd in Page 6.

The

The TABLE.

	♃	1.	Caſt Braſs	.8689	♄	.6438	Flint is
Caſt- - - -	♂	.9996	♀	.8241	☿	.5	2.721
Hammer'd	♂	.9267	☾	.721	☉	.3999	

Examp. 1. If an ♂ Spheres Diameter be 4 Inch, and weighs 9 lb. What's the Diameter of a Leaden Sphere, whoſe weight is the ſame?

Rule, As the Tabular Number for ♂, on the 7th Line, or mark of ♂, on the 8th Line: Diameter on the 31ſt Line, : : Tabular Number for Lead on the 7th Line, or the mark of Lead on the 8th Line: Diameter on the 31ſt Line.

Operat. Line. { 7 / 31 } .9996—.6438 / 4——3.44 Anſ. or { 31 / 8 } is to 4 to 3.44 Anſ. { Line / As ♂ ſo is ♄

Examp. 2. If an ♂ Sphere's Dr. is 4 Inches, and weighs 9lb; what's the Diameter of a ♄ Sphere, weighing 80 lb?

Rule, Firſt find the Diameter of a Leaden Sphere, of the ſame Weight as the ♂ Sphere, as in the preceding Example, which is 3.44.

Then ſay. As the weight of one ♄ Sphere, on the Cube: the Diameter on the Root: : the weight of the other ♄ Sphere on the Cube, : Diameter on the Root.

Operat. Line, { 7 / 31 } As .9——80 / 3.44——7.125 Dr. of a ♃ Sphere wt. 80 lb.

Examp. 3. Suppoſe the Side of a Golden Cube be 2 Inches, and weight, 5.43 lb. what's the Side of a Tin Cube of the ſame weight?

Rule, As the Tabular Number for Gold on the 7th Line, or the mark of ☉ on the 8th Line, on Proportion of Metals: Side, on the 31ſt Line: : Tabular Number for Tin, or the Mark of Tin: Anſ.

Operat. Line. { 7 / 31 } As .3999—1 / 2——2.73 or { 8 / 31 } As ☉—♃ / 2—2.73 Anſ. { line

Anſwer, The Side of a Tin Cube, equal in weight to a Golden Cube, whoſe Side is 2, is 2.75 Inches.

Examp. 4 If an Iron ball weighs 9 lb. what's the Weight of a Leaden Ball of the ſame Axis? See the 24th Line.

IXth Line, Globe Diameter 1 Inch, weight in lbs. Avoirdup.

Explan. and Uſe, If a Globe of any of the Metals following, is in Diameter 1 Inch; or a Tetraedron, Octaedron, Hexaedron, Dodecaedron's Side is 1 Inch, then their Weight in lbs. Avoirdupois, are as in

The

The TABLE.

The Name of the Metals and Stones.	Globe whose Diameter is 1 Inch.	Tetraedron whose Side is 1 Inch.	Octaedron whose Side is 1 Inch.	Hexaedron whose Side is 1 Inch.	Icosaedron whose Side is 1 Inch.	Dodecaedron whose Side is 1 Inch.
☉ Gold	.35582	.08005	.3202	.67929	1.48199	5.20547
☿ Quick Silver	.28464	.06404	.25616	.54342	1.18557	4.16427
♄ Lead	.22107	.04950	.19805	.42204	.92076	3.23414
☾ Silver	.19735	.04440	.17760	.37677	.82200	2.88723
♀ Copper	.17268	.03886	.15544	.32976	.71923	2.52630
Hamer'd ♂	.15357	.03455	.1382	.29320	.63967	2.24682
Caſt ♂	.14238	.03203	.12812	.27182	.59302	2.08298
♃ Tin	.14231	.03202	.12808	.27171	.59279	2.08214
Marble	.05726	.01288	.05152	.10933	.23851	.837810.
Common Stone	.03941	.00886	.03544	.07523	.16413	.576500

Exam. 1. If a Bullet of Lead is 10 Inches, Diameter; what's the Weight?

Rule, As 1 on the Root : Tabular Number on the Cube or to ♄ on Globe Diameter : : Diameter : Anſwer.

Operat. { 31 } 1 —— 10 { or } 31 { 1 — 10 }
Line, { 7 } .22107 — 221.07 { or } 9 { ♄ — 221.07 }
or, { 6 } 1 —— —— 1000
Line, { 24 } .22107 —— — 221.07 Anſwer.

Exam. 2. What's the Weight of a Tetraedon of Gold whoſe Side is 5 Inches?

Rule, As 1 on the Root : Tabular Number on the Cube, or mark ☉, on the Tetraedron on 9th Line : : Side on the Root : Weight on the Cube.

Operat. { 31 } 1 — 5 { or } 31 { 1 —— 5 }
Line, { 7 } .08 — 10. { Line, } 9 { .. ☉ —— 10. }

N. B. The 2 Dots before ☉ on the Tetraedron Line, ſignifies that the 8 is .08.

Work after the ſame manner for any other Body in the Table.

Ex. 3. If a ♄ Sphere weighs 20 lb. what will a ☾ Sphere weigh of the ſame Diameter?

Rule, Bring Unit on the Slide, or any other Number, but ſuppoſe unit on the Root Line, againſt ♄ on Globe Diameter 1 Inch, on the 9th Line; and againſt ☾ on the Globe Diameter, *&c.* make a Dot on the Slide, then ſet Unit on the Slide to the ♄ Weight on the Stock, and againſt the Dot on the Slide ſtands the ☾ Weight on the Cube.

Operat. { 31 } ●— 1 } then { so is ● —— As 1 { 31 } Line
Line. { 9 } ☾—♄ } { to 17. 85 Answer : 20 { 9 }

Or by this Rule, As the Tabular Number for ♄ on the Square Line, (which Number is found on the 7th Line against ♄ on the 9 Line) : Weight on the Square Line : : Tabular Number for ☾ (which is found as before) on Square : Answer.

Operat. { 7 } As . 22 —. 197
Line. { 24 } 20 — 17. 85 lb. Answer.

or, By the Proportion of Metals on the 24th Line.

Operat. { 24 { ♄ — ☾
Line, { 19 { 20 —17. 85 the Answer.

Ex. 4. What's the Weight of an Hexaedron of Marble whose Side is 6 Inches?

Rule, As 1 on the Root: Tabular Number on the Cube, or to Marble on the Hexaedron Line : : Side on the Root, Weight on the Cube.

Operat. { 31 { 1 ——— 6
Line, { 7 { .109———23. 64 Answer.
or, { 31 } 1——— 6
Line, { 10 } Mar.———23. 64 Answer.

Having the Weight to find the Diameter or Side.

Ex. If an Hexaedron of Marble weighs 23 lb. 6, what's the Side?

Rule, As the Tabular Number on the Cube, or Marble on the Hexaedron Line: 1 on the Root : : Weight on the Cube : Side on the Root.

Operat. { 31 } 1 ——to — 6 Answer
Line, { 7 } As . 109—so is—23. 64.
or, { 31 } 1 ——— 6 Answer
{ 10 } As Mar ———23. 64

And so for a Globe or any Body in the Table.

Ex. If the Diameter of a Globe of Gold be 1, and the Weight as in the Table be. 35582, What's the Diameter of a Globe of ☾ of the same Weight?

Observe, As the Diameter of the ☾ Globe, must be greater than the ☉ Globe, this is the Rule; As the Weight of the Globe of ☾ on the Cube : the ☉ Diameter on the Root, : : Weight of the ☉ Globe on the Cube : Answer on the Root.

Operat. { 7 } .197 ——— .3558
Line, { 31 } 1 ——— 1. 22 Answer.

or,

or, { 31 / 9 } As 1 — ☾ — ☉ 1—1.22 Anſwer { or } { 31 / 8 } 1 — ☉ — ☾ 1. 22 Anſwer

Proof, If the Diameter of a Silver ● is 1. 22, what's the Weight?

Operat. Line, { 31 / 7 / 9 } 1 ——— 1.22 ; .197 ——— .3558 Weight, Proof. ; ☾

13, 14. *Line*, 2*d* Face of the Stock Mark'd B. Inches and Ale Area.

To find the Content of a Circle in Ale or Beer Gallons.

Exam. What will a Cylinder contain upon 1 Inch in Depth, whoſe Diameter is 6 Inches?

Rule, Under 6 Inches on the 13th Line, ſtands 1 on the 14th Line, which ſignifies that a Circle 6 Inches Diameter and 1 Inch in Depth, contains 1 tenth of a Gallon.

N. B. If the Cylinder was 6 Inches deep, the content would be 6 Tenths of a Gallon.

Or, As 18. 95 the ☉ Gauge Point for an Ale Gallon on the Root : 6 Inches the Depth on the Square : : Diameter on the Root : Content on the Square.

Operat. Line, { 31 / 19 } 18.95 ——— 6 ; 1 ——— .1 Anſwer.

See Diviſors and Gauge Points.

15 *Line*, DIAGONAL.

To find how many Gallons of Beer any Veſſel will hold, taken as the middle Fruſtum of a Spheroid.

Rule, Put in a Rule, *&c.* at the Bung-hole ſlanting, ſo that the End may touch the Bottom of the Head; look for the Number of Inches on the Inſtrument, as the Bung-hole cuts, and againſt that on the Diagonal, is the Content of the Caſk.

Exam. Suppoſe the Diagonal meaſures 7.7 Inches, then under 7.7 Inches on the 13th Line, ſtands 1 Gallon the Anſwer on the 15th Line.

By having the Dimenſions of 1 *Caſk to find the Dimenſions of another.*

Exam. What's the Diagonal, Bung, Head and Length of a Caſk, containing 75^{g}. 37 taken as the middle Fruſtum of Spheroid; in form of another, whoſe Diagonal is 35^{in}. 56, Head 26. 37, Bung 34. 06, Length 33. 71, Content 100 Gallons.

Rule, As the Content of the Veſſel given on the Cube : Diagonal, Bung, Head, and Length on the Root : : Content

of the Caſk whoſe Dimenſions are ſought : Diagonal, Bung, Head, and Length of that Caſk.

Operat. Line,	7 / 31	As 100	Content	: :	75. 37		
	D°	: 35. 56	Diagonal	:	32. 38		Anſwer.
	D°	: 34. 06	Bung	:	31.		
	D°	: 26. 37	Head	:	24		
	D°	: 35. 71	Length	:	32. 5		

To reduce Beer Gallons to Wine.

Rule, As Wine Gauge Point on the Root : Ale Gallons on the Square : : Ale Gauge Point : Anſwer. See 68 Line.

16 Line, *Line Verſed Sines.*

Exam. In the Latitude of 51° 32′ North, the Suns Declination 23°. 29′ North, Altitude 36°. 30′ in the Afternoon, what's the Hour?

Rule, Find the Z and ½ Z of the Co-Declination, the Co-Latitude and Co-Altitude, alſo find the Difference between the Co-Altitude and ½ Z.

Then ſay, As R : Co S Decl : : Co S Lat : ¼ Sine.

Operat. 18 | 90 ——— 38.28
Line, 34 | 66.31 ——— 34.40 = ¼ Sine.

Then, As ¼ Sine : Sine ½ Z : : Sine Remainder : ⅐ Sine.

Operat. 18 | 34.40 ——— 25.44
Line. 34 | 79.14 ——— 48 = ⅐ Sine.

Over which 48 on the 18th Line, ſtands 60° 18′ on the verſed Sines (on the 16th Line) which reduced into Hours, by allowing 15° to each produces, 4^h 1′ 12″ P M, or Afternoon. If it had been in the Forenoon then ſubtracted from 12, leaves 7^h 58′ 48″ the Time in the Morning.

Note, If the Delination had been Southerly, then inſtead of taking the Complement of the Declination to 90°, add 90° thereto, do the ſame when the Declination is North in South Latitude.

17 Line — Tangents . See 29th Line.
18 Line — Sines .

Exam. Suppoſe a Ship ſails from Lat. 40° North to Lat. 20 North and makes her Diff. Longitude 20° Weſt, what's her direct Co, Dep, and Diſtance. See Page 7.

For Courſe.

As Mer. D. Lat. CA : Diff. Lon. AE : : Tan. Rad. CP · Tan. Co PM.
Op. 1397 ——— 1200 ——— 45 ——— 40.39

or, ſo is 1200 — As 1397 | 6 | 29 | Line.
Anſwer 40.39 ——— 45

For

For Departure.

As Co Sine Course CN : Diff. Lat. CI : : Sine Co NO : Dep. IK.
op. 49.21 —— 1200 —— 40.39 — 1030
or, { 18 } As 49.21 ——— 40.39
Line, { 24 } 1200 ——— 1030 Answer.

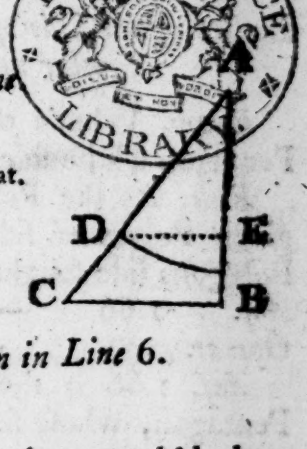
For Dist. As S. Co NO : Dep. IK : : Rad. CO : Distance, CK.
Operat. --- 40. 39 —— 1030 —— 90 —— 1582 Feet.
or, { 18 } As 40.39 —— — —— 90
Line, { 24 } 1030 —— — —— 1582 Answer.

Examp. If a Ship sails S. W. by S. 104, what's her Diff. Lat. and Dep?

Rule, As Rad. AD : Dist. AC : : S. Co. DE : Dep. BC
Operat. —— 90 —— 104 —— 33.45 —— 57.78
And : : Co. S. Co. AE : D. Lat. AB.
Operat. —— 56.15 —— 86.47

By the Sine Rhumbs on 3d and 5th Line

Operat. { 5 } 8pts — 3 — 5 /
Line, { 24 } 104 — 57.78 Dep. — 86.47 Diff. Lat.



19 Line : *Square and Polygon's Area.*

The Use of the Square Line, is shewn in Line 6.

Polygons Area.

On the Line of Squares stands Polygons Area mark'd thus 3 4 5 6 7 8 9 10 11 12 which Figures are the Number of Sides of each Polygon plac'd against their Area's as in the following Table.

3	.433	Trigon.	8	4.8284	Octagon.
4	1.	Tetragon.	9	6.1818	Nonagon.
5	1.7204	Pentagon.	10	7.6942	Decagon.
6	2.598	Hexagon.	11	9.3638	Endecagon.
7	3.6337	Heptagon.	12	11.1961	Dodecagon.

N. B. If the Diameter of a Circle is 1 the Area is .7854.

It's use, Is to find the superficial Content of any regular Polygon; that is, if 1 is the side of either of the Polygons; then their Areas are as above.

Exam. If the side of a Pentagon is 2, what's the superficial Content?

Rule,

Rule, As 1 on the Root : Tabular Number on the Square or Figure 5 which ſtands for Pentagon : : Side on the Root : Anſwer.

Operat. { 31 } 1 —— 2.
Line, { 19 } 1.72 —— 6.88. Anſwer and ſo for any other.

The Area of any Polygon given to find the Side.

Exam. If the Area of a Pentagon is 6.88 what's the Side?

Rule, As the Tabular Number for the Polygon or Figure which ſtands for the Polygon on the 19 Line: 1 on 31 Line : : Area of the Polygon : Side.

Operat. { 31 } 1 —— 2 Anſwer.
Line, { 19 } As 1.72 —— 6.88

By having the Side of any regular Polygon, to find the Side of any other regular Polygon of the ſame Area.

Exam. What's the Side of an Hexagon equal in Area to a Pentagon whoſe ſide is 2?

Rule, As the Polygon whoſe ſide is requir'd on Square : given Polygons ſide on the Root : : the Polygon given : Polygons ſide ſought.

Anſ. 1.66 —— 2 { 31 } Line.
Operat. —— As { 19 }

Anſ. 1.66 is the Side of an Hexagon equal in Area to a Pentagon, whoſe ſide is 2.

20 Line.

TOHID.

Expla. T ſtands for Tetraedron O for Octaedron, *&c.*

The TABLE.

1.73205	Tetraedron.	*Its uſe*, Is to find the Superficial Content of the Platonic Bodies. *N. B.* If 1 is the Side, the Superficiality is as per Table.
3.4641	Octaedron.	
6.	Hexaedron.	
8.66025	Icoſaedron.	
20.64573	Dodecaedron.	

Exam. If the Side of a Tetraedron is 9 what's the Superficiality?

Rule, As 1 on the Root : the Tabular Number on the Square, or to T which ſtands under the Tabular Number : : the Side of the Body : Anſwer.

Operat.

Operat. Line, 31 19 20 — 1 — 1.73 T — 9 — 140.296 Superficiality.

Exam. What's the Superficiality of an Hexaedron whose ſide is 9?

Operat. Line. 31 19 20 — 1 — 6 H — 9 — 486 Anſwer.

N. B. In this Operation the 9 runs off the Rule, therefore bring the laſt 1 on the Root Line, to ſtand againſt 6 on the Square Line, then againſt 9 on the Root, ſtands the Anſwer on the Square Line.

By having the ſuperficial Content of one Body to find the ſuperficial Content of another, if the Side is the ſame.

Exam. If the ſuperficial Content of a Tetraedon is 140.296 what's the ſuperficial Content of an Hexaedron if the Side is the ſame?

Rule, As T = Tetraedon on the Stock : ſuperficial Content on the Square Line on the Slide : : H = Hexaedron on the Stock : Anſwer on the Slide

Operat. Line, 24 20 — 140.296 As T — 486 Anſwer. H

21ſt, 22d, 23d, *Line.*

Diameter ● 1; *the Side inſcrib'd in, Circumſcrib'd about, and equal to a Sphere, is,* &c.

D I H O T.

Expla. If the Diameter of a Sphere is one Inch, one Foot, &c. then the ſide of the Dodecaedron, Icoſaedron, Hexaedron, Octaedron, Tetraedron, inſcrib'd in, circumſcrib'd about and equal to that Sphere, is as in the following Table.

If the Diameter of ● is 1; the Side of a	That may be inſcrib'd in it, is	That may be circumſcrib'd about it, is	That is equal to it, is
Tetraedron.	.816497	2.44948	1.64417
Octaedron.	.707107	1.22474	1.03576
Hexaedron.	.57735	1.	.8061
Icoſaedron.	.525731	.66158	.62153
Dodecaedron.	.356822	.44903	.40883

Exam. What's the Side of a Tetraedron that may be inſcrib'd in a Sphere whoſe Diameter is 4?

Rule,

Rule, As 1 on the Square, : Tabular Number on Square. or to T : : Diameter : Anſwer.

Operat. 6 As 1 —— 4
Line, 19 .816 —— 3.26 Anſwer.
21 T

And ſo for Circumſcrib'd, and Equal.

If the Circumference is given, then find the Diameter and work as before.

The Side of any of the Bodies being given to find the Diameter of its Inſcrib'd, Circumſcrib'd and equal Sphere.

Exam. If the Side of a Tetraedron is 8.3, what's the Diameter of the inſcrib'd, circumſcribing, and equal Sphere?

Rule, As the Tabular Number inſcrib'd, circumſcrib'd and Equal, is to one : : Side : Diameter of the circumſcribing, inſcrib'd and equal Sphere.

Operat. 21 T
Line, 19 .816 —— 8.3
24 1 —— 10.16 Diameter Circumſcribing.

22 T
19 2.449 —— 8.3
24 1 —— 3.388 Diameter Inſcrib'd.

23 T
19 1.644 —— 8.3
24 1 —— 5.04 Diameter Equal.

The Side of 1 *Body being given to find the Side of another, equal in Solidity thereto.*

Exam. If the Side of a Dodecaedron be 10, what will the Side of a Tetraedron be, whoſe Solidity is equal to the Solidity of the Dodecaedron?

Rule, As the equal Tabular Number for the Dodecaedron on Square, or D on the 23d Line : ſide on the Slide on the Square Line : : equal Tabular Number for the Tetraedron : Side of the Tetraedron.

Operat. 24 10 —— 40.21 Anſwer.
19 As .40883 —— 1.64417
Line, 23 D T

To find the Altitude of the 5 *Platonic Bodies.*

N. B. The Altitude from Side to Side, is the Diameter of the inſcrib'd Sphere, and the Altitude from Angle to Angle, is the Diameter of the Circumſcribing of all the Bodies except the Tetraedron.

Exam.

Examp. What's the Spheres Diameter, that may be inſcrib'd in, and circumſcrib'd about a Dodecaedron, whoſe Side is 9, or what's the Altitude of the Dodecaedron from one Side to its oppoſite and from one ∠ to its oppoſite?

Rule, As the Tabular Number inſcrib'd, circumſcrib'd on the Square Line, or D on 21 Line : 1 on the □ : : given Side : Altitude from ∠ to ∠ and from Side to Side.

Operat. 24 1——20 Diameter of Inſcrib'd ● Anſ.
19 As .44903——9
Line, 21 D——

Operat. 24 1——25.2 Diameter of Cir'd. ● Anſ.
19 .356822——9
Line, 21 D——

Exam. If the inſcrib'd Altitude of a Dodecaedron is 20, what's the inſcrib'd Altitude of an Icoſaedron, whoſe Side is the ſame?

Rule, As the Icoſaedron Tabular Number inſcrib'd on the Square, or I on 21 Line : Dodecaedron's Altitude on the Square : : Dodecaedron's Number on the Square, or D on the 21 ſt Line : Icoſaedron's Altitude.

Operat. Anſ. 13.6——20 24 Line
D——As 1 21

To find the Altitude of a Tetraedron.

Examp. What's the Altitude of a Tetraedron whoſe Side is 5.

Rule, As 1 the ſide on the Square Line : .81651 the Altitude on the Square Line : : the ſide : Altitude.

Operat. 6 1——5
Line, 24 .816——4.08 Anſwer.

Octagonal Slide mark'd C
24 Line.

Its uſe is ſhewn in the 6th Line.

N. B. In the middle of this Line is a Line of the Proportion of Metals &c. (if the Shape and Weight are the ſame) as in the Table.

The Table.

♃ Tin	1.	♄ Lead	1.553
Caſt ♂	1.0004	☿ Quick-Silver	2.
Hamd. ♂	1.079		
Caſt-braſs B	1.1507		
♀ Copper	1.213	☉ Gold	2.5
☾ Silver	1.386	Flint	.36749

Examp. If an Iron Ball weighs 9 lb. what's the Weight of a Leaden Ball of the ſame Diameter?

Rule, As the Tabular Number for Iron, or the mark of ♂

on the Square : Weight on the Square : : Tabular Number for ♄, or the mark of ♄ : Weight.

Operat. { 24 } 1.004——1.553
Line, { 19 } 9——13.292 Anſwer.
or { 24 } Caſt ♂——♄
Line, { 19 } 9——10.52 Anſwer.

Examp. If the Weight of an Iron Gun be 1000 lb. what's the Weight of a Braſs Gun of the ſame Shape and Dimenſions.

Rule, As the Tabular Number for C ♂ or mark of C ♂ on the Square : Weight on the Square : : Tabular Number for Braſs, or the mark of Braſs : Weight.

Operat. { 24 } 1.0004——1.1507
Line, { 19 } 1000——1150 Anſwer.
or { 24 } C ♂——B
Line, { 19 } 1000——1150 Anſwer.

Exam. If an Iron Gun Weighs 1600 lb. Caliper 3.5 Inch. what's the Weight of a Braſs Gun, of the ſame Shape whoſe Caliper is 6 Inches?

Firſt find the Weight of an Iron Gun whoſe Caliper is 6 Inches, by this.

Rule, As the Caliper of the ♂ Gun on the Root : its Weight on the Cube : : other Caliper on the Root : Weight on the Cube.

Operat. { 31 } 3.5——6
Line, { 7 } 1600——8060.64

Then ſay, As the Tabular Number for C ♂ on the Square : 8060.64 the Weight : : the Tabular Number for Braſs or mark of Braſs : Anſwer.

Operat. { 24 } 1——1.1507
Line, { 19 } 8060.64——9271.66 the Weight.
or { 24 } C ♂——B
Line, { 19 } 8060.64——9271.66 the Weight.

25 Line. Segment of a Sphere.

Examp. What's the Solid content of the Segment of a Sphere whoſe Diameter is 20, Segments Altitude 6, and Solidity in Beer Gallons of the whole=14.86?

Rule, As the Diameter on the Square : 1 on the Segment of a Sphere : : Segments Altitude : $\frac{1}{4}$ Number,

Then, As 1 on the Square : Solidity on the Square : : $\frac{1}{4}$ Nr. : Anſ.

Operat. { 6 } 20——6
Line, { 25 } 1——.216 then Line { 6 } 1——.216
{ 24 } 14.8——3.216 Anſ.

To find the Superficiality of the Segment of a Sphere.

Examp What's the Superficiality of the Segment of a Globe, whoſe Diameter is 14, and the Altitude of the Segment 4?

Rule, As the whole Diameter on the Square : Superficial content on the Square : : Altitude of the Segment : Superficial content.

Operat.

Operat. { 6 } 14——4
Line, { 24 } 616——176 ſuperficial Content of the Segment.

N. B. The Superficiality of the Globe is found by multiplying the Diameter by the Circumference, which in this Queſtion is 616.

26 Line. Segment of a Circle.

Examp. If the Diameter of a Circle be 40, verſed Sine 8, what's the Area of that Segment in Ale Gallons?

Rule, As the Diameter on the Square : 1 the Radius on the Line mark'd Segment O : : the verſed Sine : $\frac{1}{4}$ Number on the Segment.

Then, As 1 on the Square : the Area of the Circle : : $\frac{1}{4}$ Number : Anſ.

Oper. { 26 } 1—.142=$\frac{1}{4}$ Nr. then { 24 } 1——.142
Line, { 19 } As 40——8.8 Line { 19 } 4.45—.632 Anſ.

To find the Area of the Circle in Ale Gallons.

N. B. The Area may be found on the Inſtrument, if the Diameter exceeds not 3 feet, or 36 Inches. Thus, look againſt 36 Inches &c. and on the Ale Area Line ſtands the Area in Ale Gallons; but as it is above 3 Feet this is the

Rule, As the Circular Gauge Point on the 31ſt Line : 1, on the 19th Line : : Diameter : Anſwer in Ale Gallons.

Operat. { 31 } 18.95—40
Line, { 19 } 1——4.45 Area of the O in Ale Gallons upon 1 Inch in Depth.

or, As 359 on the Square : 1, on the Square : : Square of the Diameter on the Square : the Area of the Circle in Ale Gallons.

Operat. { 24 } 359——40 x 40 = 1600
Line, { 19 } 1——4.45 Anſ.

27th Line.

To find the Content of the Fruſtum of a Cone.

Examp. Let the bottom Diameter be 29 Inch. Top 23 Inch. Depth 25 Inch. what's the Content in Ale Gallons.

Rule, Firſt find the Axis of the whole Cone, 2d the Solid content of the ſame, 3d the Solidity of the leſs Cone, 4th the whole Content minus the leſs Cones Content is equal to the Content of the Fruſtum.

1ſt For Axis of the whole Cone.

Rule, As the Difference of Diameters on the Square : Depth on the Square : : greater Diameter to the whole Axis.

Operat. { 6 } 6——29
Line, { 19 } 25——120.83 Whole Axis.

For the whole Content in Ale Gallons.

Rule, As 18.95 the Gauge Point on 31 Line : $\frac{1}{3}$ of the Axis on 19 Line : : the Greater Diameter : Solid content.

Operat Line, 31 : 18.95——29
19 : 40.27——94.34 Solid Content.

N. B. Every Cone = $\frac{1}{3}$ of its Circumscribing Cylinder.

Then to find the Solidity of the Less Cone, or Segment, whose Altitude is 95.83, (*for* 120.83—25 *the Depth* = 95.83 = *the Altitude of the Segment or less Cone.*)

Rule, As 18.95 the Gauge Point on the Root, : 31.94 on the Square, : : 23 on the Root : Ans.

Operat. Line, 31 : 18.95——23
6 : 31.94——47.06 Content of the less Cone.

Then 94.34—47.06=47.28 Content of the Frustum.

N. B. The less Cones content is sooner found by this

Rule, As the whole Cones Axis on the Square : the Radius on the Line mark'd Segment of Cone : : 95.83 the less Cones Axis on the Square : .5 a Segment, on the Segment of the Cone.

Operat. Line, 6 : 120.83——95.83
27 : 1——.5 Segment.

Then, *As* 1 on the Square : whole Content on the Square, : : Segment : Ans.

Operat. Line, 24 : 1——.5
19 : 94.34——47.06 less Cones Content.

or, The Frustums content may be found by this

Rule, Multiply the Difference between the 2 Diameters by .51, which Direction is given in the inside the Stock among the Varieties, add that Product to the Less Diameter, gives a mean Diameter.

Then say, As 18.95 the Gauge Point on the Root : 25 the Depth on the Square : : 26.06 the mean Diameter on the Root : 47.28 the Content in Gallons on the Square.

Operat. Line, 31 : 18.95——26.06
6 : 25——47.28 Answer, the Content of the Frustum in Ale Gallons.

Examp. Given the Frustum of a Cone, standing on the greater end, whose Diameters are 29 and 25, Depth 25, Wet 12 Inches, To find the Diameter of the Liquor's Surface?

Rule, As the whole Depth on the Square : : Difference of Diameters on the Square : : wet Inches : $\frac{1}{4}$ Number which taken from the greater Diameter is the Answer.

Operat

Operat. { 6 } 25——12
Line, { 24 } 6——2.88 = ¼ Number.
29——2.88 = 26.12 = Diameter of Liquors Surface.

Examp. Given the Fruſtum of a Cone, Diameters 80, and 71.2 Depth 30, Content 478.8 Gallons, to find the Dimenſions of another ſuch Fruſtum, whoſe Content is 800.

Rule, As the firſt Content on the Cube : the ſeveral Dimenſions on the Root : : the ſecond Content on the Cube : the Dimenſions requir'd. See Page 19.

Operat. { 7 } 478.8—800 | 478.8—800 | 478.8——800
Line, { 31 } 80—94.98 G. Dr. | 71.2—84.48 L. Dr. | 30——35.6 Dep.

or, Having found one, as ſuppoſe 94.98 the greater Diameter, ſay by this

Rule, As the greater Diameter given on the Square : greater Diameter found on the Square : : leſs Diameter given : leſs Diameter requir'd, and ſo is the Depth given : the Depth requir'd.

Operat. { 24 } 80——71.2——and : : 30
Line, { 19 } 94.98——84.48—— : 35.6

Anſ. The required Diameters are 94.98, and 84.48, and the Depth is 35.6.

N. B. After the ſame manner the Dimenſions of Caſks may be found.

To Gauge an Elliptic Tunn cut Parallel to the Baſe.

Exam. How many Gallons will an Elliptic Tunn contain, whoſe Bottom Diameters are 38.4 Inches, and 30 Inches, and top Diameters 32 Inches, and 25 Inches, and Depth 25.

Rule, Multiply the Rectangle of the Top Diameters, by the Rectangle of the Bottom, the $\sqrt{\ }^2$ thereof, and $\frac{2}{3}$ of the Rectangles, x d. by the height, and ÷ d. by the treble round Diviſor. = Anſ.

Operat. { 24 } 1——30 { 24 } 1——25
Line, { 19 } 38.4——1152 { 19 } 32——8000
Then { 24 } 1——800
Line, { 19 } 1152——921600 its $\sqrt{\ }^2 = 960$
960 + 1152 + 800 = 2912 x 25

1077 = 67.59 Anſ.

28 Line, Segment of a Parabolic Spindle.

Its uſe, Is to find the Content of a Fruſtum or Segment.

Examp. Given a Parabolic Spindle, Axis 109.9 Inch, Fruſtums height 29.96, Diameter 29 to find the Content of the Fruſtum.

N. B. Every Parabolic Spindle is $\frac{2}{15}$ of its circumſcribing Cylinder.

Firſt

First find the Content of the whole Spindle by this

Rule, As 18.95 the Gauge Point of a circular Beer Gallon, : $\frac{2}{3}$ of the Axis or Altitude : : Diameter : Content of the Spindle.

Operat. 31 | 18.95——29
Line, 19 | 58.61——137.3 Content of the Spindle in AG.

Work after the ſame manner for any other Denomination, uſing the Gauge Points, &c.

Then to find the Segment.

Rule, As the Axis on the Square : 1 the Radius on Segment of a Parabolic Spindle : : the Fruſtum's height on the Square : $\frac{1}{4}$ Number.

Then, As 1 on the Square : the Content of the Spindle on the Square : : Segment : Solid content of the Fruſtum.

Operat. 6 | 109.9——29.96 | *Then* 6 | 1-———.129
Line, 28 | 1—— .129 | *Line*, 24 | 137.3——17.7 Anſ.

29 Line, Tangent.

Exam. Latitude 51° 32′ North, Declination 23° 29′ North, requir'd the Aſcenſional Difference.

Rule, As Radius : Tangent of Latitude : : Tangent preſent Declination : $\frac{1}{4}$ Tangent, againſt which on the Sines is the Anſwer.

Note, This can't be work'd by a direct Proportion, becauſe the 2d Term is more than Radius, therefore it is to be done thus.

As Tangent 45 on the Sine : Tangent 51.32 on the Slide : : Tangent 23.29 on the Slide : Tangent 28.40 correſponding to which on the Sines is the Anſwer.

Operat. 17 | As 45—— : 28.40 | Anſ. on the Tangt. and the
Line, 29 | :51.32——: : 23.29 | Sine equal thereto is 33.9.

Otherwiſe, As the Line of Sines is between the Tangent Line on the Stock, and the Tangent on the Slide, it may be work'd thus.

As Sine 90, = Tangent 45, on the Stock : Tangent 51° 32′ on the Slide : : Tangent 23.29 on the Slide : Sine 33.9 on the Stock.

Operat. 18 | As 90———:33.9 Anſ.
Line, 29 | :51.32———: :23.29

N. B. The foregoing is to ſhew the method when the Proportion lays in Tangents.

or thus, By the Canon on the 59th Line.

Operat. 29 | 38.28———23.29
Line. 18 | 90———33.9 Sine Aſcenſional Difference.

And

And ÷d by 15= 2h. 12m. 36s. before 6; = 3h. 47m. 24s. time of ⊙ rising.

By the Instrument.

Take the Suns rising from 6, the remainder is the Ascensional Difference.

Operat. 6h. om.—3h. 47m. 24s. = ⊙ rising; = 2h. 12m. 36s. = Ascensional Difference. See the use of the 43 Line.

To find the Sun's Rising and Setting, Length of the Day and Night.

Observe, If the Lat. and Sun's Declination are of {one / a Contrary} Name; the Ascensional Difference and six Hours is the time of Sun {Setting / Rising} and —d from 6 Hours, is Sun's {Rising / Setting.}

or, Subtract the Sun's {Rising / Setting} from 12, the Remainder is the Sun's {Setting / Rising.}

The Sun's {Setting / Rising} doubled is the Length of the {Day / Night}

or, Take the Length of the {Day / Night} from 24 Hours.

gives the Length of the {Night / Day}

Examp. Admit as in the last Example, the Ascensional Difference to be 2h. 12m. 36s. the Sun's Declination North, what time did he rise and set in that Latitude, and what was the Length of the Day and Night?

	6h. om. os.		6h. om. os.
Operat. —Asc. Diff.	2 - 12 - 36	+ Asc. Diff.	2 - 12 - 36
⊙ Rising———	3 - 47 - 24	⊙ Setting	8 - 12 - 36
⊙ Setting	8h. 12m. 36s.	⊙ Rising	3h. 47m. 24s.
	2		2
Length of Day	16 - 25 - 12	Lth. of Night	7 - 34 - 48

30 Line. *Periphery of an Ellipsis.*

Examp. Transverse Diameter 197, Conjugate 85, what's the Periphery?

Rule, As the Transverse Diameter on the Square: Periphery, or Radius, on the Periphery of the Ellipsis Line : : Conjugate Diameter : a ¼ Number. *Then*,

Then, As 1 on the Square : $\frac{1}{4}$ Number on the Square : : Tranverſe Diameter : Periphery of the Ellipſis.

Operat. { 19 } 197 ——— 85
Line, { 30 } 3.14 ——— 2.3382 or 2.34
then { 6 } 1 ——— 197
Line, { 24 } 2.3382 ——— 460.625 Periphery.

To find the Area of the Segment of an Ellipſis, cut parallel to the Tranſverſe Diameter.

Examp. Tranſverſe Diameter 200, Conjugate 90, Verſed Sine 30, Area of the Ellipſis 14137.2; what's the Area of the Segment?

Rule, As the Conjugate Diameter on the Square : Radius on the Segment of the Circle Line : : Verſed Sine : $\frac{1}{4}$ Number.

Then, As 1 on the Square : Area of the Ellipſis on the Square : : $\frac{1}{4}$ Number : Anſwer.

Operat. { 19 } As 90 —— 30 } then { 6 } As 1 —— .295
Line, { 30 } 1 —— .295 } Line, { 24 } 14137.2 —— 4170.4 Anſ.

Or thus, Find the Area of the Segment of the Circle according to the Conjugate Diameter or Inſcrib'd O. Then ſay

As the Conjugate Diameter : Tranverſe Diameter : : Area of the Segment of the Circle in Inches, or Gallons : Area of the Segment of the Ellipſis.

For the Segment of the Circle.

Operat. { 19 } 90 ——— 30 } then { 6 } 1 ——— .295
Line, { 26 } 1 ——— .295 } Line, { 24 } 6361.7 ——— 1876.7
Then { 6 } 90 ——— 1876.7 Area of the Circles Segment.
Line, { 24 } 200 ——— 4170.4 Area of Ellipſis Segment.

To find the Area of the Segment of an Ellipſis, cut parallel to the Conjugate Diameter.

Let the Example and verſed Sine be as before.

Rule, As the Tranverſe Diameter : Radius, on the Segment of a Circle : : Verſed Sine, : a $\frac{1}{4}$ Number.

Then, As 1 on the Square : Area of the Ellipſis on the Square : : $\frac{1}{4}$ Number : Anſwer.

Operat. { 19 } 200 ——— 30
Line, { 26 } 1 ——— .0959 = $\frac{1}{4}$ Number.
then { 6 } 1 ——— .0959
Line, { 24 } 14137.2 ——— 1355.75 Anſwer.

Or thus, Find the Area of the Segment of the Circle circumſcrib'd, according to the Tranſverſe Diameter.

Then

Then ſay, As the Tranſverſe Diameter on the Square : Conjugate Diameter : : Area of the Segment of the Circle : Area of the Segment of the Ellipſis.

But firſt find the Area of the great Circle.

Operat. 200 x 200 = 40000 x .7854 = 31416, Area of Circumſcrib'd Circle.

or Line, { 19 26 } 200——30 / 1——.0959 } *Line* { 6 24 } 1——.0959 / 31416——3012.7944

The Area of the Segment of the Great Circle is 3012.79.

Then Line, { 6 24 } 200—3012.79 = Area of the Segt. of the Circle. / 90—1355.75 = Area of the Segment of Ellipſis.

31 Line. Root.

See Square and Cube Root in Page 13, 14.

See Square Root, &c.

32 Line. Firſt form, or Spheriod Lying.

Examp. Given a Spheriodal Caſk, the Axis parallel to the Horizon, and the Liquor's Surface cutting the Head; whoſe bung Diameter is 33 Inches, dry Part 8 Inches, Solid Content 108.3 Gallons; to find the Vacuity.

Rule, As the bung Diameter on the Square : Radius on the Line mark'd 1ſt Lying : : dry Inches on the Square to $\frac{1}{4}$ Number.

Then, As 1 on the Square : whole Content on the Square : : $\frac{1}{4}$ Number : Vacuity; which taken from the whole Content, leaves the Gallons in it.

Oper. Line, { 6 32 } 33—8 / 1—.173 = $\frac{1}{4}$ Nr. { *then Line,* { 6 24 } 1——.173 / 108.3—18.7 Vac.

108.3 Whole Content — 18.7 Vacuity = 89.6 Gallons in the Caſk.

or, The Remaining Liquor may thus be found.

Rule, As the bung Diameter on the Square : 1, Radius on the Line mark'd 1 Lying : : wet Inches : $\frac{1}{4}$ Number.

Then, As 1 on the Square : whole Content on the Square : : $\frac{1}{4}$ Number : Anſwer.

Operat Line, { 6 32 } 33——25 / 1——.827 = $\frac{1}{4}$ Number.

then Line, { 6 24 } 1——.827 / 108.3——89.6 Remaining Liquor.

33 Line. Firſt form Standing.

Examp. Given a Spheriodal Caſk, the Axis Perpendicular to the Horizon, Length 42, dry part 8 Inches, Solidity 108.3 gal. what's the Vacuity?

Rule, As the Length on the Square : Radius or 1 Standing : : dry Inches : Segment.

Then, As 1 on the Square : : Casks Content on the Square : : Segment : Content of the Frustum; which taken from the whole Content, the Remainder is what's in the Cask.

Operat. { 19 } 42 ——— 8 } *then* { 6 } 1 ——— .172
Line, { 33 } 1 ——— .172 } *Line*, { 24 } 108.3 —— 18.5

108.3 *Whole Content* —18.5 *Content of the Frustum* = 89.8 = *What's in the Cask.*

or, The remaining Liquor may thus be found.

Rule, As the Length on the Square : 1, the Radius on the Line mark'd 1 Standing : : wet Inches : a Segment.

Then, As 1 on the Square : whole Content on the Square : : Segment on the Square : Gallons in the Cask.

Operat. { 19 } 42 ——— 34
Line, { 33 } 1 ——— .829 Segment.
then { 6 } 1 ——— .829
Line, { 24 } 108.3 ——— 89.8 in the Cask.

34th Line.

Line of Sines. See 16th Line. Page 20.

35, 36, 37, and 38 Line.

If the Cask be taken in the 2d or 3d form Lying, or Standing.

N. B. The Method is the same as in the 1st Form.

Thin Slide mark'd D.

Has a perpetual Almanac and an Astronomical Scale.

The Perpetual Almanac.

1 *Jan.* 10 *Oct.*	5 *May*	8 *Aug.*	2 *Feb.* 3 *Mar.* 11 *Nov.*	6 *June*	9 *Sep.* 12 *Dec.*	4 *April* 7 *July*	*Days of the Month.*				
A	B	C	D	E	F	G	1	8	15	22	29
B	C	D	E	F	G	A	2	9	16	32	30
C	D	E	F	G	A	B	3	10	17	24	31
D	E	F	G	A	B	C	4	11	18	25	
E	F	G	A	B	C	D	5	12	19	26	
F	G	A	B	C	D	E	6	13	20	27	
G	A	B	C	D	E	F	7	14	21	28	

Examp. 1. What Day of the Week was the 14th of *May*, 1752?

Rule, First find the Dominical Letter, which was D, under the 5th Month, and on the right Hand stands, 3.10.17.24.31, which

which ſhews the Day of the Month, the *Sundays* or 1ſt Days of the Week were in that Month. Then, the 14th Day was on *Thurſday*, or 5th Day of the Week.

Note, The Dominical Letter is found in the uſe of the 80th Line to be D, which ſerv'd to the 14th of *September*.

Examp. 2. What Day of the Week was the 30th of *October*, 1752?

Note, This Day was in the New Style, and the Dominical Letter was A, ſee the 81ſt Line.

Rule, Under the 10th Month, and on the Right Hand, ſtands 1.8.15.22.29. which were the *Sunday's* in that Month, ſo that the 29th was *Sunday* or 1ſt Day, and the 30th was *Monday*, or 2d Day of the Week.

39 Line. ☾ Age. The uſe follows.

40 Line. Moon's Southing.

To find the Moon's Southing.

Rule, Look on the Stock for the Moon's Age, and under that on the Line mark'd Moon's Southing on the Slide ſtands the Moon's Southing.

Examp. The Moon 10 Days old, what's her Southing?

Anſ. Under 10 on the ☾ Age, ſtands 8, the time of Southing in the Afternoon.

41 Line. ☾ Shining.

To find the ☾ Shining after ☉ Set, and before ☉ Riſing.

Examp. ☾ 10 Days old, how long does ſhe ſhine after ☉ Set?

Note, From new Moon to full, the Shining is counted after ☉ Set, and from full to new before ☉ Riſe.

Rule, Look for the Moon's Age on the Edge of the Stock, and under that on the Line of ☾ Shining, ſtands 8 Hours = Anſwer. See 83 Line.

42 Line. Sun's Place.

Examp. What's the Sun's Place the 21ſt of *June*?

Rule, Look on the Line mark'd Calendar, for the Day of the Month, and over that, in the Line mark'd ☉ Place, ſtands ♋, which ſignifies the ☉ is in the firſt Degree of Cancer.

43 Line. Calendar and Sun's riſing.

Examp. What Day of the Month does the Sun enter into Cancer, and what Time does he riſe and ſet in Latitude 51° 32′?

Rule, Look on the Line of Sun's place for Cancer, and underneath that, on the Calendar Line ſtands the 21 of *June*; and alſo againſt ♋, ſtand $3\frac{3}{4}$; the Sun's Riſing, *N. B.* 12—☉ Riſing is the time of ☉ Setting. See Aſcenſional Difference.

A Table of the Sun's Riſing.

Month				Month			
1	*January*	15	8	7	*July*	17	4
2	*February*	22	7	8	*Auguſt*	23	5
3	*March*	21	6	9	*September*	23	6
4	*April*	21	5	10	*October*	23	7
5	*May*	26	4	11	*November*	28	8
6	*June*	21	$3\frac{3}{4}$	12	*December*	21	$8\frac{1}{4}$

44 Line. Sun's Declination.

Examp. What's the Sun's Declination the 21ſt of *June*?

Rule, Againſt the 21ſt of *June* on the Calendar, ſtands 23°.5, on the ⊙ Declination line, which is the Declination that Day, and is the greateſt Declination. See Variation of ⊙ Declination.

45 Line. *Sun's right Aſcenſion.*

N. B. The Right Aſcenſion is the ⊙ Diſtance from Aries counted on the Equinoctial.

Let the Example be as before.

Rule, Look on the Calendar for the 21ſt of *June*, and againſt that ſtands 6 on the Right Aſcenſion Line.

46 Line Stars Right Aſcenſion.

	R. Aſs. H	′	Declin. °	′	
Pole Star	0.	32	87.	51	N
Bright * in Aries	1.	52	22.	10	N
♉ Aldebaran	4.	20	15.	55	N
Orions Right Shoulder	5.	40	7.	19	N
Syrius	6.	33	16.	21	S
♌ Lyons Heart	9.	54	13.	17	N
♌ Lyons Tail	11.	35	16.	6	N
Virgins Spike	13.	10	9.	44	S
Arcturus	14.	3	20.	39	N
Scorpions Heart	16.	13	25.	47	S
Harp	18.	28	38.	33	N
Eagles Heart	19.	37	8.	10	N
Swans Tail	20.	30	44.	19	N
Andromeda's head	23.	54	27.	34	N

The uſe of the Right Aſcenſion is ſhewn in the 82d Line, and of the Declination in the uſe of the Quadrant in taking an Obſervation.

47 Line. Line of Inches.

Its uſe is ſhewn in Line 13, 14, 15.

48, 49, Line.

Ale Area, and Diagonal; their uſe is ſhewn in the 14th and 15th Line.

To Gauge an open Tub.

Rule, Put the Inſtrument into the middle of the Tub, from ſide to ſide, and draw the Slide, or Slides out, ſo as to touch the Sides of the Tub; thereby is found the mean Diameter near enough.

Examp. Suppoſe the mean Diameter is 28 Inches; then under 28 Inches, ſtands 2.183 G. which is the Area of that Circle, 1 Inch Deep.

N. B. One Thin Slide draws out to the Left hand, the other to the Right, and to place them right, ſet the 51ſt Line to the 52d, then on the Line of Inches towards the Right Hand, ſtands 13 Inches, when it is but $\frac{1}{2}$ an Inch out of the Stock; the reaſon of that is, becauſe when any Dimenſions are to be taken above 12 Inches, then $\frac{1}{2}$ an Inch of the Bottom Slide towards the Left Hand muſt be drawn out, ſo that 12 Inches on the Stock, and $\frac{1}{2}$ an Inch at the Bottom, and the $\frac{1}{2}$ Inch at the Top Slide, make 13.

50 Line. Squares, or Numbers.

Theſe are Artificial Numbers called Logarithms, the Z of any 2 of them being = to the Product of the two Natural Numbers as before.

N. B. They are counted on the

51 Line.

Which is a Line of Equal Parts.

To find the Logarithm of any natural Number. See the Appendix.

Examp, What's the Log of 2.3.7.10.11.100?

Rule, Under the Number

2	on the 50 Line	.3
3		.477
7		.845
10	Stands on 51 Line	1.
11		1.041
100		2.

Note, The Log of 1, 10, 100, &c. are the ſame, and that every tenfold the Index increaſes 1, The Index from 0 to 10 is 0, from 10 to 100; it is 1, from 100 to 1000; 2. from 1000 to 10000; 3 &c.

To find the Logarithmetic Tangent.

Examp. What's the Logarithmetic Tangent of 40 Degrees?

Rule,

Rule, Set Tangent 45, to Number 1000 on the Square Line, then over T 40 ſtands 839, on the Square Line, which is the natural Tangent, then aganſt 839 on the 50 Line, ſtands 923 on the 51 Line, which is the Anſwer.

Obſerve, The Index from 0′ to 3′ is 6 thence to 34′, 'tis 7 thence to 5°.42′ 'tis 8 thence to 44°.59′ 'tis 9 from thence to 84°.17′ it is 10, and from thence to 89°.25′ 'tis 11; from thence to 89°.56 'tis 12, and from thence 'tis 13.

N. B. Tho' it is Impoſſible to find the very Number, yet this may be of ſome ſervice.

To find the Logarithmetic Sine.

Examp. What's the Sine of 40 Degrees?

Rule, Set S 90 to Number 1000 on the Square Line, then againſt S 40 ſtands 642 on the Square Line, which is the Natural Sine, and under 642 on the 50 Line ſtands 808 on 51 Line.

Obſerve, The Index from 0′ to 3′ is 6; from thence to 34′ it is 7, and from thence to 5° 44′ it is 8; from thence to 89° 59′ it is 9; the Rad 90°, is 10; the Index to this is 9, whence the Anſwer is 9.808.

52 Line.

Is a Foot Decimally Divided?

Farther uſes of this Line of Equal Parts may be ſeen in the Appendix.

2d Thin Slide mark'd F.

Contains the Plain Scale, *viz.*

53 Line. A Line of Rumbs, and about the middle; Miles of Longitude, and to find Diameter of a O having the Chord and Verſed Sine.

54. A Line of Chords.

55. A Line of Verſed Sines, and at the End a Scale of equal Parts.

56. Sines and Secants.

57. Tangents.

58. —— on the Edge of the Stock Semi-Tangents.

Their uſe are in Trigonometry, Navigation, &c.

The uſe of the Miles of Longitude on the 53d Line, and Chord Line under it, is to find how many Miles make 1 Degree of Longitude in any Latitude.

Examp. In the Latitude of 51°, how many Miles make 1 Degree of Longitude?

Rule, Look for 51, the Latitude on the Chord Line, and over that on the Miles of Longitude Line, ſtands 38 fere.

Operat. Line, { 53 —— 38 ferè —— M Longitude
{ 54 —— 51 —— Chords

By

By Trigonometry.

Rule, As Radius Sine 90 : 60 the Miles in 1 Degree on the Equinoctial on the Square : : Co-Sine of the Latitude 39 on Sine : Anſwer.

Operat. { 18 } ——90————39
Line, { 24 } ——60————37.76 Anſwer.

To find the Diameter of a Circle having the Chord and Verſed Sine.

Rule, $VS : 1 : : \square \frac{C}{2} : \frac{1}{4}$ Nr. | $\frac{1}{4}$ Nr. + VS = Dr. O

Explan. As the Verſed Sine : 1 : : the Square of $\frac{1}{2}$ the Chord : a $\frac{1}{4}$ Number. Then $\frac{1}{4}$ Number and the Verſed Sine is the Diameter of the Circle.

Examp. Chord 40 Verſed Sine 10, what's the Circle's Diameter?

Operat. { 24 } 10——20x20=400
Line, { 19 } 1————40

Then, 40 + 10 = 50 Anſwer.

IId Face of the Thin Slide mark'd G.

Contains 4 Lines, *viz.*

59 Line.

On which are ſeveral Canons in Aſtronomy.

R : S G D : : S ☉ L á ♈ or ♎ : P D.

Explan. As Radius : Sine of the ☉ Greateſt Declination : : Sine of the ☉ Longitude from Aries, or Libra : Preſent Declination.

Examp. What's the Sun's Declination the 6th of *November*, being 44° 16′ from Libra?

Operat. { 18 } ——90————44.16
Line. { 34 } ——23.30——16.9 Anſ.

Note, Both his Place, and Declination may be found on the Aſtronomical Scale, which ſee in the uſe thereof.

The Sun's Longitude is reckon'd from the next Equinoctial Point,

Therefore if the Sun be in ♈, ♉, ♊, ♋, ♍, or ♓; the Longitude is from ♈, but if in ♎, ♌, ♏, ♎, ♑, ♐; it is accounted from ♎, *N. B.* ♈, ♉, ♊, ♎, ♌, ♏, are called Northern Signs; and ♎, ♑, ♐, ♋, ♍, and ♓ are Southern Signs; ſo that if his place be in any of the firſt 6 Signs, the Declination is North; If in any of the latter 6, the Declination is South.

R : T ☉ L á ♈ or ♎ : : S Co G D : T ☉ R A

Explan.

Explan. As Radius : Tangent of the Sun's Longitude from Aries or Libra : : Co-Sine of the greateſt Declination : Tangent of the Sun's Right Aſcenſion.

Examp. What's the Sun's right Aſcenſion the 6th of *November*, being 44° 16′ from ♎?

Operat. { 18 } 90———66.30.
Line, { 29 } 44.16——41.48 Anſwer from Libra, and reduced into Hours = 2 Hours 47 Minutes.

Operat. { 24 } 15——41.48
Line, { 19 } 1——2.47 from ♎

Then, 2.47+12= 14^{h} 47′ from ♈, Anſwer.

Examp. 2. The Sun's place 10° 30′ in Aquarius, what's the right Aſcenſion in Hours?

N. B. His Diſtance from the next Equinoctial Point ♈, is 49° 30′, and that the Tangent 49° 30′, is ſet backward on the Tangent Line, becauſe 'tis above Radius, therefore make a Mark under Tangent 49° 30′, on the Sine Line, which is at Sine 59; then bring Tangent 45 on the Slide to the 3d Term, which is 66° 30′, and under that Mark ſtands the Anſwer on the Tangent Line, which is 47° 2′.

Operat. { 17 } T 49.30
Line, { 18 } S } .=59———66.30
{ 29 } T } 47.2 Anſ.——45 As

Then, 360—47° 2′=312.58=20° 48′.

15

SC Lat : R : : SD : ⊙ Ampl.

Explan. As the Co-Sine of the Latitude : Radius : : Sine of the ⊙ Declination : Sine ⊙ Amplitude.

Examp. The Latitude 51° 32′ North, the Sun's Declination 15° 20′ North, what's the Amplitude?

Operat. { 18 } 38.28———90
Line, { 34 } 15.20———25° 9′ Anſwer

N. B. The Amplitude is of the ſame Name as the Declination.

T C L : R : : T ⊙ Dn : : S Aſc. D.

Explan. As the Co-Tangent of the Latitude : Radius : : Tangent of the ⊙ Declination : Sine of the Aſcenſional Difference. See 29 Line.

To find an Azimuth.

R : Co S Alt : : C L : ¼ S | ¼ S : ½ Z : : Rr. : Anſ. on V S.

Explan. As Radius : the Co-Sine of the Altitude : : Co-Sine of the Latitude : ¼ Sine : Then, as the ¼ Sine : Sine of half the Sum of the Sides : : Sine of the Remainder, which

which is the Difference between the half Sum and Complement of the Declination: a 7th Sine, and that measur'd on the Versed Sine is the Azimuth requir'd.

Examp. In the Latitude of 51° 32′ North, the Sun's Declination 20° North, Altitude 40° A M; the Azimuth from the North required?

Operat. { As Radius : C S Alt. :: C S Lat. : ¼ Sine
S 90 : S 50 :: S 38.28 : S 28.28

Then, { As 4th Sine : S ½ Z :: S Rem : 7th Sine
S 28.28 : S 79.14 :: 9.14 : S 19.19

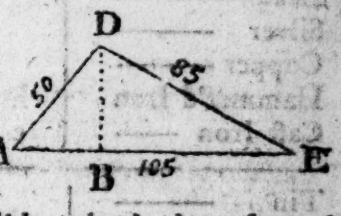
Corresponding whereunto, on the Line of Versed Sines is the Answer 109°.48′ from the North.

N. B. In South Latitude the Operation is the same as in North, only the Azimuth is found from the South; after the same manner the Azimuth of a Star may be found.

3 Sides of an Oblique Triangle given, To find the ∠'s

Rule, As Ba : Z Sides :: Difference Sides, Difference Segments.

Explan. As the Base : Sum of the Sides :: Difference of the Sides : Difference of the Segments of the Base.



Examp. Suppose a Ship sails N E 50 Leagues, then South Easterly 85 Leagues, and from thence 105 Leagues to the place from whence she first sail'd, what's her second Course, and last Course back?

Rule, { As the Base : Z Sides :: *x* Sides : Diff. of the Segt.
105 : 135 :: 35 : 45.

Then, Add the Base and the Difference of the Segment together, ½ the Z is the ⌐ Segment, and ½ the X is the ⌙ Segment.

Operat. 105 + 45 = 150 and ÷d by 2, = 75 ⌐ Segment.
And 105 − 45 = 60 and ÷d by 2, = 30 ⌙ Segment.

For the Angle A.

Rule, { As Ad : Rad :: A B : Co-Sine ∠ D A B = ∠ A D B
50 : S 90 :: 30 : 36° 53′.

Then, 90 − 36° 53′ = 53° 7′ = ∠ D A B; which added to N E (=45°) makes 98° 7′, or South Easterly 81° 53′, so that the Course from E to A is W by N ¼ W, back to the Place first sail'd from.

Again, As D E 85 L. : Rad :: B E 75 : S ∠ B D E 61° 55′; whose Complement to 90° is 28° 5′, = ∠ E; which subtracted from 81° 53′ leaves 53.45, or S E ¾ E nearest, the Course from D to E.

Thin Slide mark'd G.
60, 61, 62, Line.

Diagonal. Ale-Area, and Inches.

Examp. Suppoſe the Diagonal be 27 Inches, how many Gallons will that Caſk contain?

Rule, Look for 27 on the Line of Inches, and over that, on the Diagonal line ſtands 43.7; the Gallons that the Caſk will hold when full. See 13, 14, 15, 48, and 49 Line.

The Writing on the Inſide the Stock Mark'd H.
63, 64, 65, and 66 Line.

Solid Inch in 1 *Pound Avoirdupois* + □ + O *Gauge Points.*

		63 Line		
Gold	☉	1.472	1.213	1.368
Quick Silver	☿	1.84	1.356	1.53
Lead	♄	2.369	1.539	1.736
Silver	☾	2.654	1.629	1.837
Copper	♀	3.033	1.74	1.964
Hammer'd Iron	h ♂	3.41	1.846	2.083
Caſt Iron	c ♂	3.679	1.938	2.163
		64 Line		
Tin	♃	3.68	1.919	2.164
Marble	—	9.146	3.024	3.421
Common Stone	—	13.292	3.645	4.113
Honey	—	18.402	4.29	4.84
Salt Water	—	25.271	5.02	5.67
Cheeſe	—	27.04	5.2	5.87
Water, Wine	—	27.663	5.26	5.933
		65 Line		
Green Oak	—	29.53	5.434	6.13
Oyl	—	30.668	5.537	6.247
Dry Oak	—	35.858	5.988	6.755
Wheat	—	38.633	6.215	6.973
Raw Starch	—	34.8	5.9	6.66
White Soft Soap	—	25.56	5.05	5.704
Green Ditto	—	25.67	5.06	5.716
		66 Line		
Hard Soap	—	27,14	5.21	5.9
Tallow Neat	—	31.4	5.6	6.32
Tallow Groſs	—	30.28	5.5	6.2
Gun Powder	—	31,06	5.57	6.287

Examp. What's the Weight of a Cheeſe 20 Inches Diameter, and 4 Inches thick?

Rule,

Rule, As the Circular Gauge Point on the Root : Depth on the Square : : Diameter : Anſwer.

Operat. { 31 } 5.87——20
Line, { 19 } 4——46.5 ferè

Examp. What's the Weight of a Cube of Gold, whoſe Side is 6 Inches ?

Note, 1.472 ſolid Inches of Gold = 1 Pound and 1.213 is the Square Gauge Point.

Rule, As Tabular Number for ⊙ on the Square : 1 on the Square : : Cube of the Side : the Anſwer.

Operat. { 6 } 1.472——216
Line, { 24 } 1——146.74 Anſwer.

Or, As Gauge Point for ⊙ on Root, Depth on the Square : : the Side : the Anſwer.

Operat. { 31 } 1.213——6 Side
Line, { 19 } 6——146.74 ferè Anſwer.

Or, By the Hexaedron, Side 1 Inch.

Operat. { 31 } 1——6
Line, { 10 } .6792——146.74 Anſwer.

Examp. What's the Weight of a Globe of Gold, Diameter 6 Inches ?

N. B. As the Globe's Weight or Solidity is $\frac{11}{21}$ of the Hexaedron ; ſay by this

Rule, As 21 on the Square : 11 on the Square : : Hexaedron's Weight : Globe's Weight.

Operat. { 6 } 21——146.74
Line, { 24 } 11——76.86 Anſwer.

or thus, Find the Solidity of the Globe ; which is 113.142, then ſay, as the Solid Inches in 1lb. Avoirdupois on the Square : 1lb. on the Square : : Solid Inches on the Square : Weight.

Operat. { 6 } or { 24 } 21——216
Line, { 24 } or { 19 } 11——113.142 Solidity of Globe
or { 31 } $\sqrt[3]{21} = 2.76$——6
Line, { 7 } ——11——113.142
Then { 6 } or { 24 } 1.472——113.142
Line, { 24 } or { 19 } 1——76. 86 Anſwer.

Or, By the Tabular Nnmber Globe Diameter 1 Inch.

Operat. { 31 } 1——6
Line, { 7 } .3558——76.86 Anſwer.

Or thus, By having the Weight of the Hexaedron, to find the Weight of the Globe. *N. B.* Againſt Gold on the Hexaedron Line, ſtands .67929 and againſt ⊙ on Globe Diameter 1 Inch is .35582.

Say, As .679 the Hexaedron's Weight, on the Square: .355 the Globe's Weight on the Square: : 146.74 the Hexaedron's Weight on the Square: 76.86 the Globe's Weight.

Or thus, Set a Dot, either on the Root, or Square Line, againſt the Hexaedron of Gold, on the 10th Line; and alſo againſt Globe Diameter, 1 Inch of Gold, on the 9th Line, then move the Hexaedron's Dot to the Hexaedron's Weight on the Cube, and againſt the Globe's Dot, on the Slide, ſtands the Globe's Weight on the Cube; this is the ſhorteſt and beſt way.

66 Line.

□ and O Diviſors, and □ and O Gauge Points.

To find the Round Diviſors.

Rule, As .785398 : 1 : : □ Diviſors : O Diviſors.

Examp. What is the O Diviſor for a Superficial foot = 144 Square Inches.

Operat. Line, { 24 / 19 } .785389 —— 144 / 1 —— 183.34 } *or* { .7854 —— 144 / 1 —— 183.34

□ Root, Diviſors = Gauge Points.

Explan. The Square Root of the Diviſors are the Gauge Points.

Examp. What's the Gauge Point for a Foot, containing 144 Square Inches?

Operat. Line, { 6 / 31 } 1 —— 144 / 1 —— 12 = Anſwer.

After the ſame manner any other Gauge Point may be found.

Gauge Points on Root : L on the Square : : M Diameter : Content of Caſks = Cyl.

Explan. As the Gauge Points on the Root Line : Length of the Caſk on the Square Line : : mean Diameter : Content of the Caſk. *Note*, The mean Diameter reduces the Caſk to a Cylinder. See Varieties. Page 47.

Examp. If the mean Diameter of a Caſk be 28.76, and the Length 32.5; how many Gallons of Ale, or Beer will the ſame contain?

Note, The Circular Diviſor for a Beer, or Ale Gallon, is 359.05; and the Gauge Point is 18.95.

Operat. Line, { 31 / 19 } 18.95 —— 28.76 / 32.5 —— 74.86 Anſwer.

67 Line.

New Gauge Points = Root of 10 Times the O Diviſors.

Explan. New Gauge Points are equal to the Root of 10 Times the old Diviſors.

Examp. What's the New Gauge Point for a Square Foot?

Operat.

Operat. $\sqrt{144 \times 10} = 37.94$ the New Gauge Point.

Or thus, To find the New Gauge Point; As 1 on the Square Line : the old Gauge Point on Root : : 10 on the Square Line : Anſwer on Root.

Operat. } 19 { 1 ——— 10
Line, } 31 { 12 ——— 37.94 New Gauge Point.

A G □ 282 : 359.05 | 16.79 : 18.95.

Explan. The Square Diviſor for an Ale Gallon is 282, and the Round Diviſor is 359.05.

The Square Gauge Point is 16.79; Round Gauge Point is 18.95.

W G 231 : 294. 118 | 15. 19 : 17. 14.

Explan. The Square Diviſor for a Wine Gallon is 231, and the Round Diviſor is 294.118.

The Square Gauge Point is 15.19, and the Round Gauge Point is 17.14.

M *a* B 2150.4184 : 2738 | 46.37 : 52.32.

Explan. The Square Diviſor for a Malt Buſhel is 2150.4184, and the Round Diviſor 2738 the Square Gauge Point is 46.37, and the Round Gauge Point 52.32.

□ Foot 144 : 183.34 | 12 : 13.54.

Explan. The Square Diviſor for a Square Foot is 144; and the Round Diviſor is 183.34.

The Square Gauge Point is 12, and the Round Gauge Point is 13.54.

Sol F 1728 : 2200.158 | 41.57 : 46.9.

Explan. The Square Diviſor for a Solid Foot is 1728, and the Round Diviſor is 2200.158.

The Square Gauge Point is 41.57; and the Round Gauge Point is 46.9.

68 Line.

B Meal in Fat for Starch 2300 : 2928.45 | 47.95 : 54.1 makes 25lb.

Explan. The Square Diviſor for a Buſhel of Meal in the Fat for Starch is 2300; and the Round Diviſor 2928.45, the Square Gauge Point is 47.95; and the Round Gauge Point is 54.1. each Buſhel is allow'd to make 25 Pounds of Starch.

The uſe of the Square and Round Diviſors and Gauge Points.

Suppoſe a Board be 20 *Inches Square, how many Square Feet are there in it?*

Rule, As the Square Inches in a Foot on the Square : 20 the Breadth on the Square : : 20 the Length : Anſwer.

Operat.

Operat. { 24 } 144——20
Line, { 19 } 20——2.77 Anſwer.

By □ Gauge Point.

Rule, As 12 the Root of the Diviſor, on the Root: 1 on the Square: : Side of the Square on the Root: Anſwer on the Square.

Operat. { 31 } 12——20
Line, { 6 } 1——2.77 Anſwer.

Circular Diviſors and Gauge Points.

Examp. How many Square Feet are there in a Circle, whoſe Diameter is 20 Inches?

Rule, As the Circular Diviſor on the Square: Diameter on the Square: : Diameter on the Square: Anſwer.

Or, As the O Diviſor on the Square: 1 on the Square: : Square of the Diameter: Anſwer.

Operat. { 6 } 183.34——20
Line. { 24 } 20——2.185 Anſwer.
or { 6 } 183.34——20x20 = 400
Line, { 24 } 1—— 2.18 Anſwer.

By the Gauge Point.

Line, { 31 } 13.54——20
{ 19 } 1——2.18 Anſwer.

Examp. How many Gallons of Wine will a O Tunn contain upon 1 Inch in Depth, whoſe Diameter is 60?

Rule, As the O Diviſor on the Square: Diameter on the Square: : Diameter: Anſwer.

Operat. { 6 } 294——60
Line, { 24 } 60——12.23 Anſwer.

By the Gauge Point.

Rule, As the O Gauge Point on Root: 1 on the Square: : Side: Anſwer.

Operat. { 31 } 17.14——60
Line, { 19 } 1—— 12.23 Anſwer.

To Reduce Ale Gallons to Wine Gallons. See Page 20.

Examp. How many Gallons of Wine are equal to 100 Gallons of Ale?

Rule, As the Solid Inches in a Wine Gallon on the Square: Ale Gallons on the Square: : Solid Inches in an Ale Gallon: Anſwer.

Operat.

Operat. { 24 } 231 ——— 282
Line, { 19 } 100 ——— 122 Wine Gallons.

54 G = H. B.

Explan. 54 Gallons one Hogſhead of Beer.

63 G = H. W.

Explan. 63 Gallons one Hogſhead of Wine.

Varieties of Caſks

Caſk Gaugs 1 Variety B—H x .7 + H = mean Diameter. M F Spd.

Explan. Caſk Gauging. 1ſt Variety, the Bung minus the Head multiply'd by .7, that Product, and the Head Diameter is equal to the mean Diameter of the middle Fruſtum of a Spheroid.

That is, Multiply the Difference between the Head and Bung by .7, or more exact by .697; add that Product to the Head Diameter, the ſum is the mean Diameter, which reduces the Caſk to a Cylinder.

Examp. Bung 32 Inch. Head 25 Inch. Length 32.5 Inch. what's the Content in Ale Gallons?

32—25=7 then 7 x .7 = 4.9 then 4.9 + 25 = 29.9 mean Diameter.

Then, As the Circular Diviſor on the Square : Length on the Square : : Square of the mean Diameter : Anſwer.

Operat. { 6 } 359.05 ——— 29.9 x 29.9 = 894
Line, { 24 } 32.5 ——————————— 80.9 Anſwer.

Or by the Gauge Point.

Operat. { 31 } 18.95 ——————— 29.9
Line, { 19 } 32.5 ——————— 80.9 Anſwer.

2 V. 68 M F Parabolic Spindle.

Explan. Multiply the Difference between the Head and Bung by .68, add that Product to the Head Diameter, gives the mean Diameter of the middle Fruſtum of a Parabolic Spindle, and having the mean Diameter and Length the Solidity is found as in the laſt Example.

3 V. 58 L F 2 Parabolic Conoids.

Explan. Multiply the Difference between the Head and Bung by .58 that Product and Head Diameter is the mean Diameter, for the lower Fruſtum of 2 Parabolic Conoids.

4 V. 52 L F 2 Hyperbolic Conoids.

Explan. Multiply the Difference of the Head and Bung by .52; that Product and Head is the mean Diameter, for the lower Fruſtum of 2 Hyperbolic Conoids.

69 Line.

5 V. 51 L F 2 Cones.

Explan.

Explan. Multiply the Differenee between the Head and Bung by .51 that Product and Head is the mean Diameter, for the lower Fruſtum of 2 Cones.

Weight of a Cubic Inch in Ounces Avoirdupois.

69 Line.

Fine Gold	☌	11.3656	Plate Braſs		4.83211
Standard Gold	☉	10.9304	Caſt Braſs		4.6303
Quick Silver	☿	8.1017	Steel		4.5445
Lead	♄	6.55388	Caſt Iron	♂	4.4229
Fine Silver	☾	6.4183	Block Tin	♃	4.23663
Standard Silver	☾	6.0965	Fine Marble		1.56885
Copper	♀	5.20836			

70 Line.

Common Glaſs		1.49303	Milk		.589362
Alabaſter		1.08447	Urine		.588791
Dry Ivory		1.05554	Sea Water		.594894
Ale		.609929	Pump Water		.578697
Box Wood		.596057	Claret		.574646
Beer Vinegar		.59107	Linſeed Oyl		.539345
Sack		.5905			

71 Line.

Proof Brandy		.536796	Honey		.86944
Dry Oak		.536569	Cheeſe		.5916
Oyl Olive		.53835	Green Oak		.54176
Oyl Turpentine		.41582	Wheat		.41408
Stone		1.2036			

N. B. There is ſome ſmall Difference between this Table and the others. If this by Experiment is found to be more exact, then in Order to find the Weight of any of the Bodies; multiply the Solid Inches in the Body by the Weight of a Solid Inch.

The Uſe of the Table.

By knowing the Solid Inches or Feet that are in any Body, to find the Weight, or by having the Weight to find the Solidity.

Examp. What is the Weight of a Solid Foot of Dry Box in lb. Avoirdupois?

Rule, As 16, the Ounces in a lb, on the Square: Tabular Number; which is the Weight of a Cubic Inch in oz. Avoirdupois, on the Square : : Inches in the Foot: Anſwer in lb. Avoirdupois.

Operat. { 24 } 16 ——— 1728
Line, { 19 } 0.596 —— 64.36 Anſwer.

After

After this manner, the Weight of any Body may be found and the contrary.

Examp. If a Piece of Box Weighs 64.37lb. what's the Solidity?

Rule, As the Tabular Number for 1 Inch : 16 oz. : : Weight : Solidity in Inches.

Operat. Line, { 6 } As .596——64.37
{ 24 } 16——1728.

By the foregoing Table may be known if any of those Bodies will sink or swim in Water, Oyl, Brandy, &c. *Note*, if the Inch of Water, &c. is heavier than an Inch of the Body enquired into, that Body will swim and the Contrary; and also by it may be known, what Quantity of Wood &c. may be put to any Body heavier than Water, to make that Body swim, also what Weight added to any Body lighter than Water will make it just float, sink, &c. also, what any Body immers'd in Oyl, Honey, Brandy, &c. will weigh.

Examp. 1. Which is heavier Cheese or Milk?

Answer, Cheese is heavier, for an Inch of Milk is .589362, and an Inch of Cheese is .5916 : Therefore Cheese will sink in Milk.

Examp. 2d. What Weight added to 3 Feet of Dry Oak, will just make the said Piece sink in Pump Water?

Rule, Find the Difference between an Inch of Water and an Inch of Oak.

Inch of Water	.578697
Inch of Oak	.536569
Difference	.042128

Then Line, { 6 } 16 ——1728x3=5184
{ 24 } .042128——13.65 ferè

Answer, 13.65 lb. put on that Piece of Oak, will just make it float, or be level with the Water, and if any greater Weight be put on, it will sink.

By the Reverse of this, 'tis easy to find what Quantity of Oak, &c. will float any Body heavier than Water.

Examp. What Weight in lb. Avoirdupois, added to 3 Feet of Oak will make the said Piece sink in Honey?

Inch of Honey	.86944
Inch of Oak	.536569
Difference	.332871

Then Line, { 6 } 16 ——1728x3=5184
{ 24 } .332871—— 107.85 Answer.

Examp. To find what an Inch of Lead will weigh in Water, Honey, &c.

Rule. Subtract the Weight of an Inch of Water, or Honey, &c. from the Weight of an Inch of Lead, &c. the Remainder is the Weight.

Operat.					
	Inch Lead	6.553885	Inch of Lead	6.55388
	Inch Water	.578697	Inch of Honey	.86944
Difference	- -	5.975188	Difference	- - 5.68444

Answer, An Inch of Lead in { Water / Honey } weighs { 5.975. / 5.684. }

How much Lighter is a Foot of Dry Oak, than a Foot of Water?

Rule, Find how much lighter 1 Inch is.

Thus,

Inch of Water	.578697
Inch of Oak	.536569
Difference	.042128

Then Say, { As 1 Inch : Difference : : 1 Foot : Answer.

Operat. Line, { 24 } 1 ——— 1728
{ 19 } .042128 ——— 72.797

Answer, A Foot of Oak is 72.797 oz. lighter than a Foot of Water.

Weight of a Cubic Foot in lbs. Avoirdupois.

New Castle Coal 67.75. Gravel 109.3125. Common Sand 85.25. Pump Water. 62.7734375. Wood Ashes 58.3125. Bay Salt 54.0625. White Peas 50.5 Field Beans 50.5. Best Wheat 48.5. White sea Salt 43.75. Barley 41.125. Wheat Meal unsifted 31. Malt two Months old 30.25. White Oats 29.5. Rye Meal unsifted 28.

Explan. A Cubic Foot of Gravel weighs 109.3125 lb. and so of the Rest.

To find the Weight of any of the Bodies mention'd in the Table.

Examp. If a measure be 3 Feet Square, and 2 Feet Deep, how many Pounds Avoirdupois of Salt will that hold?

Rule, First find the Solidity.

Then say, { As 1 : Tabular Number for Salt : : Solidity : Answer.

For the Solidity, { As 1 on Root : Depth on the Square : : Side : Ans.

Operat.

Operat. { 31 } 1——3
Line, { 19 } 2——18 Solid Content in Feet.
For the Weight, { *Operat.* { 6 } 1——18
Line, { 19 } 43.75——787.5 Anſwer.

Examp. If a round Meaſure be 3 Feet Diameter, and 2 Feet Deep, how many Pounds of Salt will it hold?

Rule, Firſt find the Solidity in Feet, which is done by Multiplying the Square of the Diameter in Inches, by the Depth in Inches, and divide the product by the Circular Diviſor for Feet, the Quotient is the Solid Content in Feet.

Then, As 1 on the Square: Tabular Number: : Solid Content: Anſwer.

Operat. { 6 } 2200.158——36 Squar'd.
Line, { 24 } 24——14.13 Solid Content in Feet.
Then { 6 } 1——14.13
Line, { 24 } 43.75——618.18 Anſwer.

To find the Solidity in Feet by the Circular Inch Gauge Point.

Thus, As the Circular Gauge Point on the Root: Depth on the Square: Diameter: Anſwer.

Operat. { 31 } 46.9——36
Line, { 19 } 24——14.13 Solid Content in Feet.

or thus, To find the Solidity in Foot meaſure by the Circular Gauge Point for a Foot.

Operat. { 6 } 1.273——3×3=9
Line, { 24 } 2——14.13 Solid Content in Feet.
or thus { 31 } 1.128——3
Line, { 19 } 2——14.13 Anſwer.

Mechanic Powers.

To find the force of any Leaver.

L of Sh E *à* Ful: L of L E *à* F: : 1: Pr.

Explan. As the Length of the ſhorter end from the Fulciment, or Prop. Length of the longer End from the Fulciment: : 1: Power of that Lever.

Examp. If a Lever be 10 Feet long and the Fulciment or Prop. on which the Lever is put, is at 2 Feet from the End, what's the force of that Lever?

Oper. { 24 } 2——1
Line, { 19 } 8——4 fold

So that one Man, by the help of this Lever, may raiſe as great a Weight as 4 Men can do without it.

To find what Power will be ſufficient to raiſe a given Weight, with a given Lever.

Rule, Diſt Pr à. Ful : Diſ Wt à F : : Wt : Pr.

Explan. As the Diſtance of the Power from the Fulciment : Diſtance of the Weight from the Fulciment : : Weight : Power.

Examp. If a Lever 11 Feet Long, reſts on a Fulciment 1 Foot from the End, and has a Weight of a 1000 lb. reſting on the ſhorter end, what Power apply'd to the longer End, will be able to raiſe that Weight?

Operat. { 24 } 10——1000
Line, { 19 } 1——100 Anſwer.

or, One Man, ſuppoſing him capable to lift 100 lb. is able to raiſe the Weight of 1000 Pounds.

To find the force of any Axis in Peritrochio.

Rule, Sem. Dr. Spin. : S Dr. Wh : : 1 : For Wl.

Explan. As the Semidiameter of the Axis or Spindle : the Semidiameter of the Wheel : : 1 : Force of that Wheel.

Examp. If the Diameter of the Axis be 6 Inches, and the Diameter of the Wheel 5 Feet, what's the Force of the Wheel?

Operat. { 24 } 3——1
Line, { 19 } 30——10 Anſwer.

or, A Power equivalent to one Pound, apply'd to the Circumference of the Wheel, will raiſe a Weight of 10lb. apply'd to the Circumference of the Axis, or one Man with this Power, will be as ſtrong as 10 without it.

To find what Power will be ſufficient to raiſe a given Weight with a given Wheel.

Rule, S Dr. Wl. : S Dr. A : : Wt. : Pr.

Explan. As the Semidiameter of the Wheel : the Semidiameter of the Axis : : Weight : Power.

Examp. What Power will be ſufficient to raiſe a Weight of 1000lb. with a Wheel as in the laſt Example?

Operat. { 24 } 30——1000
Line, { 19 } 3——100 Power.

Anſwer,

Anſwer, A Power or Force of 100 lb. Weight.

To find the Force of any Screw.

Rule, Diſt of Thd : O, des à Hand : : 1 : For Sc.

Explan. As the Diſtance between the Threads of the Screw : the Circumference deſcrib'd by the Handle : : 1 : force of the Screw.

Examp. If the Diſtance of 2 Threads of the Screw, be 1 Inch $\frac{1}{2}$, and the Handle whereby the Screw is turn'd about, projects 3 Feet $\frac{1}{2}$ from the Center of the Screw, what's the force of that Screw ?

Operat. { 24 } 1.5——1
Line, { 19 } 264——176 ferè

N. B. One Man with this Screw, will be as ſtrong as 176 Men without it.

To find the Force, or Advantage gain'd by an Inclining Plain.

LH of an inclining P : L : : 1 : Advantage gain'd.

Explan. As the Perpendicular Height of an Inclining Plain : its Length : : 1 : Advantage gain'd.

Examp. If the Height of an inclining Plain be 2 Feet, and the Length be 8 Feet, what Advantage in raiſing a Weight, is gain'd thereby ?

Operat { 24 } 2——1
Line, { 19 } 8——4 fold Advantage, gain'd by it.

N. B. One Man may raiſe a Weight to the top of that Inclining Plain, as eaſily as four Men can without it.

To find the force of any Machine, or Engine compoſed of 2 or more of the Mechanic Powers.

Rule, Firſt find the Space or Diſtance, mov'd by the Power in the ſame time as the Weight is remov'd any other Space, which is eaſily found, by comparing the ſeveral parts of the Engine ; then ſay, as the motion of the Weight : motion of the Power : : 1 : Force of that Engine.

Examp. In the Engine call'd the perpetual Screw, and Axis in *Peritrochio* ; Let the Diameter of the Axis be 3 Inches $\frac{1}{2}$, and Diameter of the Wheel 3 Feet $\frac{1}{2}$, let this Wheel have 50 Teeth, and the Screw to make one Revolution for each Tooth, and let the Length of the Handle, or Winch by which the Screw is turn'd about be 14 Inches, what's the force of this Engine ?

Operat. { 24 } 11——1
Line, { 19 } 4400——400 fold Anſwer.

Or

Or one Man with this Engine, ſhall be as ſtrong as 400 Men without it; for while the Weight is raiſed the Space of 11 Inches, equal to the Circumference of the Axis, the power at the Winch, will have moved 4400 Inches; for the Winch makes 50 Revolutions while the Wheel makes 1, and each Revolution of the Winch is 88 Inches; therefore ſay, as 11 the motion of the Wheel: 4400 the motion of the Power:: 1: 400 the Anſwer.

1 : □ Seconds :: 16 : Diſt.

Explan. As 1 : Square Seconds any heavy Body is falling from any Height:: 16: Diſtance in Engliſh Feet, it will deſcend in that time.

Examp. How far will a heavy Body deſcend in one Minute?

Oper. { 24 } 1 ——— 16
Line, { 19 } 3600 ——— 57600 Feet, Anſwer.

Sound about 13 M, in 1 Minute.

Explan. Sounds flies about 13 Miles in 1 Minute.

Examp. How long will the Sound of a Canon be going 20 Miles, admitting nothing to interrupt it?

Operat. { 24 } 13 ——— 20
Line, { 19 } 1 ——— 1.53 Min. Anſwer.

Aſtronomy.

☉ on Ax á E to W 26 Days.

Explan. The Sun moves on its Axis, from Eaſt to Weſt, in 26 Days.

☿, ☉, 88 Days.

Explan. Mercury moves round the Sun in about 88 Days.

♀, 225 Days.

Explan. Venus moves round the Sun in about 225 Days.

⊖ with ☾ abt ☉ in 1 Yr.

Explan. The Earth with the Moon about the Sun in 1 Year.

75 Line.

♂, 2 Years.

Explan. Mars, about the Sun in 2 Years.

♃ abt ☉, 12 Yrs, with his 4 Sat.

Explan. Jupiter moves about the Sun in about 12 Years with his 4 Satellites.

♄ abt ☉, abt 30 Yrs with his 5 ☾'s

Explan. Saturn moves about the Sun in about 30 Years with his 5 Moon's.

☾ ⊖. 1 Month.

Explan. The Moon moves round the Earth in one Month.

⊖ on Ax á W to E 24 Ho.

Explan. The Earth moves on its Axis, from Weſt to Eaſt, in about 24 Hours.

Fix

Fix * Po Ec 25920 + own Ax á W to E 24 Ho.

Explan. The fixed Stars move on the Poles of the Ecliptic, in 25920 Years; and own their on Axis, from West to East, in about 24 Hours.

Algebra.

Addition.

$a + a = 2\,a.$

N. B. This mark + ſtands for and, or plus, and that any Number, or Letter, having no Sign prefix'd; is to be accounted as if it had plus before it.

Explan. $a + a$ make $2\,a$, that is; Suppoſe a repreſents 1 Shilling, then 1 Shilling and 1 Shilling = 2 Shillings.

$a - a =$.

Explan. a minus a is = to Nothing; that is, ſuppoſe a repreſents 1 Shilling, then 1 Shilling wanting 1 Shilling is = to Nothing.

$-a + a =$

N. B. This is the ſame as the 2d Example.

$-a - a = -2\,a$

Explan. Minus a and minus a = to minus $2\,a$.

That is, If a repreſents the Loſs of 1, then the Loſs of 1 and the Loſs of 1 is the Loſs of 2.

76 Line. *Subſtraction.*

$5\,a + 3\,a = 2\,a.$

Explan. From $5\,a$ take $3\,a$ the remainder is $2\,a$, that is, ſuppoſe a ſtands for 1 Shilling, then $5\,a = 5$ Shillings: From 5 Shillings take 3 Shillings, the remainder is 2 Shillings.

N. B. In order to make this Rule plain, Change the Sign of the Subtrahend, and add the Quantities together, the ſum will be equal to the Difference. If the Subtrahend has the ſame Sign as the other Quantity, after that its Sign is chang'd; that is, if both are +, or both are —, the ſum will have the ſame Sign, but if 1 is +, and the other —, then the Sum will have the ſign of the greater Quantity; for — deſtroys + and + deſtroys —, as is plain by the

Examp. From $5\,a$ take $3\,a$.

N. B. The ſign of the Subtrahend being chang'd, the Queſtion will ſtand thus.

$5\,a - 3\,a = 2\,a.$

Here 1 Quantity is +, that is $+ 5\,a$, and the Subtrahend is $-3\,a$, and by the Rule — and + deſtroy each other, that is, as far as the Value of — is, which is $3\,a$, and it is plain that

the Difference between 5 and 3 is 2, and as the greater Quantity has the Sign of +, therefore the Answer will be + 2 *a*.

$$5a - 3a = 8a.$$

N. B. Minus 3 *a* being chang'd into + 3 *a*, then the sum of 5 *a* and 3 *a*, is 8 *a*, which is the Difference of 5 *a* — 3 *a*.

Multiplication.

$$a \times a = aa.$$

Explan. *a* multiplied by *a*, = *a a* or a^2.

That is, If a Board be 8 Feet Long, and 8 Feet Broad, the Superficiality is 64.

Note, Like sign give +, and unlike —.

$$-a \times -a = aa.$$

Explan. Minus *a*, Multiply'd by — *a*, is equal to + *a a*.

$$a \times -a = -aa.$$

Explan. *a* multiply'd by — *a*, is equal to — *aa*.

Why, $\left\{\begin{matrix}-\\+\end{matrix}\right\}$ by Minus, makes $\left\{\begin{matrix}+\\-\end{matrix}\right\}$ will appear in Compound Multiplication.

The 1st Example in Multiplication proved by Compound Multiplication.

Note, 8 Feet = to 5 Feet + 3 Feet (which is the Side or Root of the Square) and as it is composed of 2 Parts, it is called a Binomial Root, which signifies a Root composed of 2 Names, or parts.

If this Binomial Root be squar'd, the Product will be = to the Square of the Sum of the Parts, as 8 xd by 8 = 64.

Or, The Square of the Binomial Root is = to the Square of the greater Part, and the Square of the less Part, and twice the Rectangle of both the Parts.

Operation by Figures.

5 + 3
5 + 8
+15 + 9
25 + 15
25 + 30 + 9 = 64 = 8 □d

Or by Letters.

If I call 5 by the Name of *a*, and 3 by the Name of *b*, then the Square will be $aa + 2ab + bb$.

Operation.

Operation.

$$\begin{array}{r} a+b \\ a+b \\ \hline ab+bb \\ aa+ab \\ \hline aa+2ab+bb=25+30+9 \end{array}$$

Examp. If a Board is 8 Feet Long, that is 5 Feet + 3 Feet and 2 Feet Broad, that is, 5 Feet wanting 3 Feet, what's the ſuperficial Content?

N. B. As it is a Board 8 Feet Long, and 2 Feet Broad, the ſuperficial Content will be 16 Feet.

Operation by Figures.

$$\begin{array}{r} 5+3 \\ 5-3 \\ \hline -15-9 \\ 25+15 \\ \hline 25---9=16=8\times 2 \end{array}$$

by Letters.

$$\begin{array}{r} a+b \\ a-b \\ \hline -ab-bb \\ aa+ab \\ \hline aa---bb=25-9=16 \end{array}$$

Note, Here the minus 15, deſtroys the plus 15, as alſo does the $-ab$, the plus ab, and that a Binomial Root xd by a Reſidual, produces in the product the Square of the ⌐ part minus the Square of the ⌙, for 5. ſquar'd. — 3 ſquar'd, = 16.

Hereby it appears that + by — makes —.

Examp. Suppoſe a Board was 5 Feet wanting 3 Feet long, and 5 Feet wanting 3 Feet Broad, what's the Superficial Content? *N. B.* 'tis the ſame as a board 2 Feet long, and 2 Feet broad.

Operation by Figures.

$$\begin{array}{r} 5-3 \\ 5-3 \\ \hline -15+9 \\ 25-15 \\ \hline 25-30+9=4 \end{array}$$

by Letters.

$$\begin{array}{r} a-b \\ a-b \\ \hline -ab+bb \\ aa-ab \\ \hline aa-2ab+bb=25-30+9=4 \end{array}$$

Here the Square of the Reſidual Root is = to the Square of the ⌐ part, and Square of the ⌐ part, — twice the Rectangle of both Parts .... Hereby it appears that — by —, makes +.

Examp. Suppoſe a Board is 5 Feet Long, and 3 Feet Broad, what's the ſuperficial Content?

By Letters, Suppoſe *a* ſtands for 5, and *b* ſtands for 3, then *a* multiply'd by *b*, is equal to *ab*.

$$a \times b = ab = 15 = 5 \times 3$$

Diviſion.

In the laſt Example in Multiplication, was given a Board 5 Feet Long, and 3 Feet Broad, the Product was 15 Feet, and by Letters, the Length was called *a*, and the Breadth *b*, the ſuperficial Content was *a b*, and on the Inſtrument in Diviſion, the Example is *ab* divided by *a*, the Quotient is equal to *b*, that is *ab* the ſuperficial Content divided by *a* the Length gives *b*, the Breath, or 15 divided by 5 gives 3 the Breadth.

$$\frac{ab}{a} = b \text{ and } \frac{15}{5} = 3$$

Note, In Diviſion, if the ſame Letter or Letters be in the Dividend as in the Diviſor, croſs the ſame out of both and the remainder is the Quotient.

That is, As *a* is in the Dividend, and *a* in the Diviſor, croſs them both out and then the remaining Letter *b*, is the Quotient.

Compound Diviſion.

As Diviſion is the Reverſe of Multiplication, take the product of the firſt Example in Compound Multiplication.

Examp. Divide $aa + 2ab + bb$ by $a + b$.

$a + b \,)\, aa + 2ab + bb \,-\, (a + b$ Anſ.

$aa + ab$

$ab + bb$

$ab + bb$

N. B. The Subtrahend's ſigns are to be chang'd, and then it will be $2ab - ab = ab$ and $aa - aa =$ nothing.

⌐ᶜ Eq. | + □ $\frac{1}{2}$ Coeff. on both Sides.

Explan.

Explan. If a Quadratic Equation is not compleat, that is, if there are only 2 Parts in the Equation on one Side, it ſignifies, that the Root is compos'd of 2 Parts, and conſequently the Square muſt conſiſt of 3; therefore the 3d muſt be found to compleat it; in order to which this is the

Rule, To each Part of the Equation, add the Square of $\frac{1}{2}$ the Coefficient, or Letter known, that works or is found with the unknown, or ſought Quantity.

Examp. Suppoſe $aa + b\ a = c$; then the Coefficient or Letter known which works with a the Quantity unknown is b; therefore add the Square of $\frac{1}{2}b$ on each ſide, and the Equation will be compleated, thus $aa + ba + \frac{1}{4}bb, = c + \frac{1}{4}bb$. Having compleated the Square, find the Root thus, take the $\sqrt{\ }$ of the 1ſt and laſt Terms (neglecting the middle part) which is $a + \frac{1}{2}b$ and it will ſtand thus, $a + \frac{1}{2}b = \sqrt{c + \frac{1}{4}bb}$; but as the Value of a is only wanted, tranſpoſe $+ \frac{1}{2}b$ with the contrary Sign, and 'twill be $a = \sqrt{c + \frac{1}{4}bb} - \frac{1}{2}b$ that is, a is equal to the Square Root of c, and $\frac{1}{4}bb$; and after the Value of the Root aforeſaid is found, then take $\frac{1}{2}b$ from it, the Remainder is the Value of a.

Examp. 2d. If the 2 Parts are $aa + bb$, then the Root is $a + b$, and when Compleated 'tis $aa + 2ab + bb$.

Examp. 3d If the 2 Parts are $aa + 2ba$; then take $\frac{1}{2}$ of the $2ba$ the Quotient is ba, and divided by a, the Quotient is b, whoſe Square is bb; then, the Square compleated is $aa + 2ab + bb$.

To find the Root of a Square.

What's the Square Root of $aa - 2ab + bb$?

Anſwer, $a - b$, found by neglecting the middle part, and taking the Square Root of aa, which is a; and the Square Root of bb, which is b.

Queſtions producing a Simple Equation.

Examp. What Number added to 11 will make 14?

General Rule, Inſtead of ſuppoſing a Number, ſet any Letter (in order to prevent many Figures in the Operation) then work with that Letter, as if it was the real Number, till the imagined Number, and the Number to be added (as in this Queſtion) are equal to the Number ſought and ſo forth, according to the Conditions of the Queſtions.

Operat. Suppoſe	1	$x =$ Number Sought.
Then $1+11$	2	$x + 11$
$2=14$	3	$x + 11 = 14$ Conditions of the Queſtions.
$3-11$	4	$x = 14 - 11$
$4=5$	5	$x = 3$ QEI

Operat. $14 - 11 = 3 = x$. Proof 3 Nr. Sought $+ 11 = 14$.

Note, That nothing but the unknown Quantity muſt ſtand on one Side of the Equation, and as 11 is with it, it muſt be brought on the other Side, with the contrary Sign and then it is $x = 14 - 11 = 3$.

Examp. To find a Number to which if 11 be added, and 7 ſubtracted from the ſame, *viz.* From the 1ſt Number, the ſum of the Addition may be double the Remainder.

Let $11 = a$
and $7 = b$

Suppoſe,	1	$X =$ The Number Sought
$1 + a$	2	$x + a =$ the Z, or Sum
$1 - b$	3	$x - b =$ the X, or Remainder
$2 = 3 \times 2$	4	$x + a = 2x - 2b$, CQ
$4 - x$	5	$a = x - 2b$
$5 + 2b$	6	$a + 2b = x$
$6 =$	7	$x = a + 2b$ QEI $= 25$

Operation.

$a = 11$
$2b = 14$

$x = 25$ QEO

Proof

25 Nr. Sought	25 Nr. Sought
$+11$ Nr. Added	7 Subtracted
36 Sum =	to twice 18 Remainder

Queſtions producing a Quadratic Equation.

What Number is that, which being ſquared, and alſo multiply'd by 8, the ſum of the ſaid Square and Product may be = to 384?

Let $8 = b$
and $384 = c$

Suppoſe,

Suppose,		
1 ⊙ 2	1	x Number Sought
1 × b	2	$x\,x$ = Square
2 + 3 = c	3	$b\,x$ = Product
4 Compl.	4	$x\,x + b\,x = c$ = C Q
5 ω 2	5	$x\,x + b\,x + \frac{1}{4}bb = c + \frac{1}{4}bb$
6 − $\frac{1}{2}b$	6	$x + \frac{1}{2}b = \sqrt{^2}\,c + \frac{1}{4}bb$
	7	$x = \sqrt{^2}\,c + \frac{1}{4}bb - \frac{1}{2}b = 16$ Q E I

Operation.

$c = 384$
$+ \frac{1}{4}bb = 16$

$c + \frac{1}{4}bb = 400$ its $\sqrt{^2}$ is 20

$-\frac{1}{2}b = 4$

$x = 16$ Q E O

Proof
$x = 16$ $b = 8$
$x = 16$ and $x = 16$

$xx = 256 + bx = 128 = c = 384$ Q E P

77 Line.

As 14 : 11 : : Square Diameter : Area.

Explan. As 14 : 11 : : Square of the Diameter : Area of the Circle.

Note, This Rule is near enough for Common use.

More exact, Thus as 1 on the Square : .785398 or (.7854) on the Square : : Diameter : Area.

Examp. If a Circle's Diameter is 7 Feet, what's the Area of that Circle?

Operat. Line, 24 | 14 —— 7×7 = 49
19 | 11 —— 38.5 Answer.

Or, As $\sqrt{^2}$ of 14, which is 3.74 on the Root : 11 on the Square : : 7 on the Root : Answer.

Oper. Line, 31 | 3.74 — 7
19 | 11 — 38.5 Anſ.

more exact Line, 24 | 1 ——— 49
19 | .7854 — 38.48

21 : 11 : : Cu. D^r ⊙ : Co^t. or Sup. Co^t. × $\frac{1}{6}$ Dr.

Explan. As 21 : 11 : : Cube of the Diameter : Solid Content of a Globe, or the Superficiality multiply'd by $\frac{1}{6}$ of the Diameter.

Examp. If the Diameter of a Globe is 3 Inches, what's the Solidity?

Operat.

Operat. { 6 } 21——27
Line, { 24 } 11——14.142 Solid Content.
Or { 31 } $\sqrt[3]{21}$ = 2.759——3 Cube Root of 27
Line, { 7 } 11——14.142 Solid Content.

7 : 22 : : Diameter : Circumference.

Explan. As 7 : 22 : Diameter : Circumference.

Examp. If the Diameter is 3, what's the Circumference?

Operat. { 6 } 7——3
Line, { 24 } 22——9.428 Circumference.

Or more Exact, As 1 on the Square : 3.14159 on the Square : : Diameter : Circumference.

Operat. { 6 } 1——3
Line, { 24 } 3.14159——9.424 Circumference.

Dr. ●, xd. Cir. = Sup. Co^{t}.

Explan. A Globe, or Sphere's Diameter multiply'd by the Circumference, is equal to the Superficial Content.

Examp. If the Diameter of a Sphere is 3, what's the Superficiality?

Operat. { 6 } .1——3
Line, { 24 } 9.424 Cir.——28.274 Anſwer.

7 : 22 : : Rad. x by Sid. Cone : Sup. Cont.

Explan. As 7 : 22 : : Radius multiply'd by the Side of the Cone : Superficial Content.

Examp. If a Cone's Diameter is 6 Feet, and ſlanting Side 3 Feet, what's the Content in Square Feet and Square Yards?

Operat. Line, { 6 } 7——3×3 = 9
for Feet. { 24 } 22—— 28.28 Anſwer in Feet.
Operat. Line, { 6 } 9——28.28. *N. B.* 9 □ Feet = 1 □ Yd.
for □ *Yards.* { 24 } 1——3.14 Anſwer.

Or, { 6 } 63——9
{ 24 } 22——3.14 □ Yards.

1 : .7 : : Dr : Rt □, in Cir.

Explan. As 1 : .7 : : Diameter of a Circle : Root of a Square, that may be inſcrib'd in that Circle.

Examp. Suppoſe the Diameter of a Circle is 2, what's the Side of a Square that may be inſcrib'd in that Circle?

Then { 6 } 1——2
Line, { 24 } .7——1.4 Anſwer.

1 : .88 : : Dr : Rt of the Square = O Area.

Explan. As 1 : .88 : : Diameter of any Circle, to the ſide of a Square whoſe Area is equal : Area of that Circle.

Examp. Suppoſe the Diameter of a O is 2, what's the ſide?

Operat { 6 } 1——2
Line, { 24 } .88——1.76

7 : 22 : : Dr x by Ax : Sup Cyl.

Explan.

Explan. As 7 : 22 : : Diameter, multiply'd by the Axis, or height : Superficial Content of the Cylinder.

more Exact, As 1 : :3.14159 : : &c.

Examp. Admit a Cylinder, or Rolling Stone is in Diameter 6 Feet, and Altitude 3 Feet, what's the Superficial Content?

Operat. Line, { 6 } 7——6x3 = 18
{ 24 } 22——56.5 Answer.

14 : 11 : : □ Tr + Con Dr : Ar Ell.

Explan. As 14 : 11 : : Rect ∠ of the Transverse and Conjugate Diameter : Area of the Ellipsis.

Examp. What's the Superficial Content of an Ellipsis 9 Feet Long, and 6 Feet Broad?

Operat. Line, { 6 } 14——9x6 = 54
{ 24 } 11——42.43 fere

more Exact Line, { 6 } 1——54
{ 24 } .7854——42.41

1 : 1 .273 : : Ar : □ Dr.

Explan. As 1 : 1 .273 on the Square : : Area of a Circle : Square of the Diameter.

Examp. If the Area of a O be 38.5, what's the Diameter?

Operat. Line, { 6 } 1——38.5
{ 24 } 1.2732——49 and its $\sqrt{}^{2}$ is 7 the Diameter.

$$12 : L : : \frac{G}{4} : MM, OT.$$

Explan. As 12 on Root : Length in Feet on the Square : : $\frac{1}{4}$ Girt in Inches : Market or customary Measure for round Timber.

Examp. Suppose the Length be 15 Feet, and Girt 3 Feet, what's the Market Measure?

Operat. Line, { 31 } 12——9
{ 19 } 15——8.43 Answer.

N. B. The Girt is taken in, or about the middle of the Length.

To find the true Content, measure it as the Frustum of a Cone if tapering; if it is a Cylinder, then as such.

Or thus, As 11 on the Square : 14 on the Square : : Customary measure to the true measure near enough.

$$12 : L : : \frac{B \text{ and } D}{2} : MM \square T$$

Explan. As 12 on the Root : Length in Feet on the Square : : Breadth and Depth in Inches, taken in the middle of the Piece, ÷ by 2, to the customary way of measuring Square Timber.

N. B.

N. B. This way of measuring Square Timber, may indifferently do, when the Piece is near Square; but when it is much otherwise, the Error is considerable.

Examp. If a Piece of Timber is 25 Inches Square at the great End, and 9 Inches Square at the Less, and 20 Feet Long, how many Feet of Timber are in that Tree?

Operat. Line, { 31 } 12——17
{ 6 } 20——40.13 Customary way.

25 Breadth + 9 Depth = $\frac{34}{2}$ = 17 the $\frac{1}{3}$ Z.

To find the true Content.

Rule, To the treble Product of the Dimensions at each end, add the Square of their Difference, then say, as the treble Square Divisor: that Z : : Length : Answer.

25 × 9 × 3 = 675 Treble Product, 25 — 9 = 16 that Squar'd = 256 = Square of Difference then 675 + 256 = 931.

Operat. Line, { 6 } 5184——240
{ 24 } 931—— 43.101 true Content.

The Customary Measure is 40.13
The true Measure 43.101

Or, Find a mean Proportion between the Area of both ends, that mean Proportion and Area of both ends × d by $\frac{1}{3}$ of the height, all in Inches; and divide by 1728 is the Answer, or true Content.

25×25=625
9×9 = 81
625
5000
50625 its $\sqrt{^2}$ is 225

225 mean Proportion
625 Area of 1 End
81 Area of the other End
931×80 = 43.101 Answ. true Content.
1728

N. B. The Frustum of a Cone is measur'd by this Rule, instead of the Side in the Square Pyramid, use the Diameters, and divide by the Circular Divisors.

Examp. 2. If a Piece of Timber be 32 Inches Broad, and 20 Inches Deep at the ⌐ end, and 10 Inches Broad, and 6 Inches Deep at the ⊏ end, and 18 Feet Long; how many Feet of Timber are in that Piece according to the true measure?

32×20=640 Supl. Content of one End
10×6 = 60 Supl. Content of the other End
640×60=38400 $\sqrt{^2}$ = 195.959 mean Area.
195.959+640+60×72=$\frac{64509}{1728}$ = 37.33 Answer.

Or,

Or, The mean Area may be found thus on the Inſtrument, ſet 60 on the Square Line to 60 on the Root Line; then againſt 640 on the Square Line, is 196 ferè, on the Root Line.

Operat. } 6 } 60——640
Line, } 31 } 60——196 ferè.

N. B. As it is impoſſible to find the exact Number on the Rule, it being ſo large, therefore uſe the method aforegoing in all ſuch Caſes.

The Cuſtomary way.

$$\frac{32+10=42}{2}=21 \qquad \frac{20+6=26}{2}=13$$

Then, $21\times13=273\times216=\frac{58968}{1728}=34.12$.

The Cuſtomary Content is 34.12
The true Content is 37.33

Cone $\frac{1}{3}$ Cylinder, or $\frac{11}{42}$ Paral.

Explan. The Solid Content of a Cone is equal to $\frac{1}{3}$ Part of the Solid Content of the circumſcribing Cylinder, or $\frac{11}{42}$ of the circumſcribing Parallelepipedon.

Examp. Let the Diameter at the Baſe be 56.5 Inches, and the height 96 Inches, I demand the Content in Feet, Ale and Wine Gallons, Malt Buſhels, Pounds of ſoft Soap, Tallow Pounds Groſs, Tallow Pounds Neat, Pounds of hard Soap, Pounds of Green ſoft Soap, Pounds of green or raw Starch, and Buſhels of Meal in fermentation for Starch?

Rule, Square the Diameter and multiply that by $\frac{1}{3}$ of the Altitude, divide the laſt Product by the proper Diviſors for Circles, and it gives the Content in Feet, Ale, &c.

By the Round Diviſors.

2200.158			46.43 Feet
359. 05			284.51 Ale Gallons
294.118			347.32 Wine Gallons
2738		ſo is	37.31 Malt Buſhels
32.54	on □	56.5×56.5	3139.28 White ſoft Soap
38.55	is to 1	×32=102152	2649.85 lbs of Tallow Groſs
39.98	on □	on □	2555.08 lbs of D° Neat
34.56			2958.68 lbs of hard Soap
32.68			3125.82 lbs of green ſoft D°
44.32			2304.873 lbs of gr. or raw Starch
2928.45			34. 8 Buſhels of meal in Ferm.

By the Gauge Point.

46.9	on the Root	32 on the Square	: :	56.5 on the Root	46.43 Feet
18.95					284.51 Ale Gallons
17.14					347.32 Wine Gallons
52.32					37.31 Malt Bushel
5.7					3139.28 White soft Soap
6.2					2649.8 lbs Tallow Gross
6.3					2553.8 lbs D° Neat
5.9					2978.68 lbs hard Soap
5.72					3125.92 lbs of green soft D°
6.66					2304.87 lbs of gr. or raw Starch
54.1					34.8 Bushels of meal in Ferm.

Or, As a Cone is $\frac{11}{42}$ Parallelepipedon, find what the Parallelepipedon will hold; Side 56.5 Inches, Height 96. by this

Rule, As Square Divisor : the Length : : Square of the Side : Content in Ale Gallons.

Operat. Line, for Ale Gallons. { 24 } 282 — 56.5×56.5=3192.25
{ 19 } 96 ——— 1086.72 Ale Gallons.

Then say, As 42 on the Square : 11 on the Square : : Solidity of the Parallelepipedon : Solidity of the Cone.

Oper. Line, { 24 } 42 ——— 1086.72
{ 19 } 11 ——— 284.6 Ale Gallons.

Answer, 284.6 which is about 1 Tenth more than the former method.

Examp. What's the Solid Content of a Cone in Feet, whose Diameter at the Base is 36 Inches, and Perpendicular Altitude 3 Feet?

Rule, As the Circular Divisor for a square Foot : $\frac{1}{3}$ of the height in Feet : : Square of the Diameter in Inches : Answer.

Operat. Line, { 24 } 183.34 —— 1296 Square Diameter.
{ 19 } 1 ——— 7.07 ferè Content in Feet.

Or, As the Cone is $\frac{11}{42}$ of a Parallelepipedon.

Say, As 42 : 11 : : Content of the Parallelepipedon; which is 27 : Answer, 7.07.

If the Dimensions of the Cone are all in Feet;

First find the Circular Divisor for a Foot,

Thus, As .785398 or .7854 on the Square on : 1.□ : : 1: Circular Divisor.

Then say, As the Circular Divisor for a Solid Foot, is to $\frac{1}{3}$ of the height : : Square of the Diameter in Feet : Solid Content.

Operat. Line, { 24 } .7854 —— 1
{ 19 } 1 ——— 1.273 Circular Divisor.

Then Line, { 24 } 1.273 —— 9
{ 19 } 1 ——— 7.07 ferè Solid Content.

Square

□ △, = ⅓ Par

Explan. A Square Pyramid is ⅓ of a Parallelepipedon, of the ſame Baſe and Altitude.

Examp. Admit the Side is 3 Feet, and the height 3 Feet, what's the Solid Content?

Rule, As 3 on the Square: 1 on the Square:: Solidity of the Parallelepipedon: Anſwer.

Operat. { 6 } 3——27
Line, { 24 } 1—— 9 Anſwer.

△ Pyr = ⅐ of a Cube ferè.

Explan. A Triangular Pyramid is near ⅐ of a Cube.

Examp. Admit the Side is 3 Feet, and height 3 Feet, what's the Solid Content?

Operat. { 24 } 7——27
Line, { 19 } 1——3.855 Anſwer.

But as is not juſt the ⅐; find the Content, by firſt finding the Perpendicular of the Baſe, which Baſe is a Trigon, and then multiply the Side by ½ the Perpendicular; for the Area of the Baſe. See Page 11, 21.

Then ſay, As 1: Area of the Baſe:: ⅓ of the Pyramid's height: Solidity of the ſame.

To find the ⊥ of the Trigon.

Operat. { 6 } 1——3
Line, { 24 } .866—2.598 = ⊥ of the Trigon
then { 6 } 2——3
Line, { 24 } 2.598—3.897 Area of the Baſe.

Then for the Solidity of the Pyramid.

Operat. { 6 } 1——1
Line, { 24 } 3.897—3.897 = True Solidity of the Trian. △

Cyl $\frac{11}{14}$ Par.

Explan. A Cylinder is $\frac{11}{14}$ of a Parallelepipedon, of the ſame Baſe and Altitude.

Examp. If a Cylinder is 3 Feet high, and 3 Feet Diameter, what's the Content in Feet?

As the Cylinder is $\frac{11}{14}$ of a Parallelepipedon, and the Content of that before is 27, this is the

Rule, As 14 on □ :: 11 on the Square:: the Content of the Parallelepipedon: Content of the Cylinder.

Operat. { 6 } 14——27
Line, { 24 } 11——21.214 Content of the Cylinder.

● is $\frac{11}{21}$ Cube, or ⅔ Cyl.

Explan. A Globe is $\frac{11}{21}$ of a Cube, or ⅔ of a Cylinder.

Examp. If a Globe is 3 Feet Diameter, what's the Content?

Rule, As 21 on the Square : 11 on the Square : : Cube of the Diameter : Solid Content.

Or, As 3 on the Square : : 2 on the Square : : Cylinder's Content : Answer.

Operat. { 6 } 21 ——— 27
Line, { 24 } 11 ——— 14.14 Content of the Globe.

Or { 6 } 3 ——— 21.214
Line, { 24 } 2 ——— 14.14 Answer.

Or { 31 } √3 of 21 = 2.76 ——— 3
Line, { 7 } 11 ——— 14.14 Answer.

Par Conoid $\frac{1}{2}$ Cyl, or $\frac{11}{28}$ Par.

Explan. A Parabolic Conoid is $\frac{1}{2}$ a Cylinder, or $\frac{11}{28}$ of a Parallelepipedon.

Examp. Let the Diameter at the Base be 106 Inches, and Height 96, what's the Content in Solid Feet?

Rule, First find the Solidity of the circumscribing Cylinder, Then as the Parabolic Conoid is $\frac{1}{2}$ of the Cylinder; say, as 2 : 1 : : Cylinder's Content : Conoid's Content.

Oper. { 31 } 46.9 ——— 106
Line, { 6 } 96 ——— 490.26 Cylinder's Content.

Then { 6 } 2 ——— 490.26
Line, { 24 } 1 ——— 245.13 Answer.

The Cylinder's Content is 490.26
Conoid's Content is 245.13.

Or, As the Conoid is $\frac{11}{28}$ of the Parallelepipedon, find the Solidity of the Parallelepipedon, and say as 28 on the Square : 11 on the Square : : Parallelepipedons Content : Content of the Conoid.

Operat. { 6 } 41.57 ——— 106
Line, { 31 } 96 ——— 624.22 Co^{t}. of Par^{a}.

Or { 6 } 28 ——— 624.22
Line, { 24 } 11 ——— 245.2 Answer.

Hyper Cond $\frac{5}{12}$ of a Cylinder, or $\frac{55}{168}$ Par.

Explan. Hyperbolic Conoid is $\frac{5}{12}$ of a Cylinder, or $\frac{55}{168}$ of a Parallelepipedon.

Rule, Find the Content of the Cylinder, or Parallelepipedon as before; and then of the Conoid, and so for the Spindle and Spheroid following.

Par Spin $\frac{8}{15}$ Cyl, $\frac{88}{210}$ Par.

Explan. A Parabolic Spindle is $\frac{8}{15}$ of a Cylinder, or $\frac{88}{210}$ of a Parallellepipedon.

Sph^{d}, $\frac{2}{3}$ Cyl, $\frac{22}{42}$ Par.

Explan. A Spheroid is $\frac{2}{3}$ of a Cylinder, or $\frac{22}{42}$ of a Parallelepipedon.

□ H — □ B = ⊐ I

Rule,

Explan. The Square of the Baſe, ſubtracted from the Square of the Hypothenuſe; the Remainder = to the Square of the L.

Examp. Let the Hypothenuſe be 15, Baſe 10, what's the L?

Operat. { 6 } 1——15
Line, { 24 } 15——225 = Square of the Hypothenuſe?

Line, { 6 } 1——10
{ 24 } 10——100 = Square of the Baſe.

225 = Square Hypothenuſe, — 100 = Square Baſe, = 125 = Square L and its $\sqrt{2}$ is 11.17 the L.

N. B. The Square of the Hypothenuſe, — Square of L, = Square of the Baſe; and the Square of the L, + Square Baſe. = Square of the Hypothenuſe.

O : O : : □ Drs.

Explan. Circles are in Proportion to each other, as the Square of their Diameters.

N. B. If the Diameter of one Circle is 2, and the Diameter of another is 4, the Area of the 2d Circle, is 4 times the Area of the firſt Circle.

Examp. Let the Diameter of 1 Circle be 2, and the other 4, what's the Area of both Circles?

Rule, As 1 on the Square : .7854 on the Square : : Square of Diameter : Area.

Operat. { 6 } 1——4
Line, { 24 } .7854——3.14 Area of the Circle.

Or { 31 } 1——2
Line, { 6 } .7854——3.14 Anſwer.

Or { 6 } 1——16
Line, { 24 } .7854——12.56 Area of the 2d Circle.

Or { 31 } 1——4
Line, { 6 } .7854——12.56 Anſwer.

● : ● : : C b, Dr.

Explan. Globes are in Proportion to each other as the Cube of their Diameters.

Examp. If the Diameter of one Globe is 2 Inches, and the Diameter of another 4, what's the Solid Content of each?

Rule, As 21 on the Square : 11 on the Square : : Cube of the Diameter : the Solidity.

Or, As the $\sqrt[3]{}$ of 21 on the Root : 11 on the Cube : : Diameter : Solidity.

Operat. { 6 } 21——8 and ſo is——64
Line, { 24 } 11——4.19——33.52 Anſwer.

Or { 31 } 2.76——2 and ſo is —4
Line, { 7 } 11——4.19——33.52 Anſwer.

So that the Solidity of the 2d. is 8 times the firſt.

□

□ Dr of ○ : Area :: □ Dr : Area ○.

Explan. As the Square of the Diameter of any Circle : Area of that Circle : : Square of the Diameter of any other Circle : Area of that Circle.

Examp. Suppoſe the 2 Diameters are 2 and 4 the Area of the 1ſt is 3.14 then

Operat. { 6 } 4 ——— 16
Line, { 24 } 3.14 ——— 12.56 Anſwer.

Par Ar = ⅔ □.

Explan. A Parabola's Area is equal to ⅔ of its circumſcribing Parallelogram.

Examp. Let the Length or Axis be 21, Breadth or Ordinate 12, what's the Area of the Parabola?

Operat. { 6 } 1 ——— 12
Line, { 24 } 21 ——— 252 Area of □
then { 6 } 3 ——— 252
Line, { 24 } 2 ——— 168 Area of the Parabola.

∠ : Op S : : ∠ : Op S.

Explan. As 1 Angle : its oppoſite Side : : any other ∠ : its Oppoſite Side, and as 1 Side : its oppoſite Angle : : another Side : its oppoſite Angle.

Yr. + 1 ÷ 19, Rr = Pr Cha 1ſt *Jan* = Yr ☉ + ☾ Fin Aſp.

Explan. The Year and 1 Divided by 19, the Remainder is the Prime or Golden Number. It changes the 1ſt of *January*.

N. B. In the Space of 19 Years, all the Lunations and Aſpects between the Sun and Moon do nearly return to the ſame Place they were 19 Years before. If nought remains, the Prime is 19. The Reaſon of adding 1 is becauſe at our Saviour's Birth, the Prime or Golden Number was 1.

Examp. What will the Golden Number, or Prime for the Year 1758 be?

Operat. $\frac{1758+1}{19}$ = 92 = Revolutions; the Remainder = 11 = Prime.

N. B. The Golden Number is the ſame in both Accounts.

Pr xd by 11, ÷ 30; Rr = E P, O S, Ch 1ſt Mar.

Explan. The Prime or Golden Number multiply'd by 11, divided by 30, the Remainder is the Epact for the Old, or Julian Account.

Note, The Epact is the Number of Days between the Sun's Year of 365 Days, and the Moon's of 354, it changes 1ſt of *March*.

Examp. What's the Epact for the Year 1758 Old Stile?

Operat. $\frac{11 \text{ Golden Nr} \times 11}{30}$ the Remainder is 1 = Epact O. S.

O S, E P; — 11 = N S Epact.

Explan.

Explan. The Old Stile's Epact minus 11, is the New Stile Epact.

If the Old Epact is leſs than 11, add 30 to it, then ſubtract; the Remainder is the New Stile's Epact.

Examp. What's the New Stile's Epact for the Year 1758?

Operat. 1 Old Epact + 30 = 31 — 11 = 20 = New Stile Epact.

Or thus, Bate 1 of the Golden Nr, Xy the Remainder by 11, and ÷ by 30 the Remainder is the Anſwer, New Stile.

Operat. 11 — 1 = 10 × 11 = $\frac{110}{30}$ the Remainder = 20 Anſ.

Cy ⊙ = Rev 28 Yrs D L + L Yr Exp.

Explan. The Cycle of the Sun is a Revolution of 28 Years, in which Time the Dominical Letters and Leap Years expire.

Examp. What's the Cycle of the Sun for the Year 1753?

Rule, Divide the Year and 9, by 28, the Remainder is the Cycle.

Operat. 1753+9 = 1762 and ÷d by 28 the Remainder = 26 = Cycle.

N. B. 9 is added, becauſe at our Saviour's birth the Cycle was 9.

Yr, + $\frac{1}{4}$ + 4 ÷ 7, the Remainder Sub à 7 the Rr = D^{l} L; A = 1, B 2, Old Stile.

Explan. The Year its $\frac{1}{4}$ and 4 divided by 7; the Remainder ſubtracted from 7, the laſt Remainder is = to the Dominical Letter; counting A 1, B 2, C 3, D 4, E 5, F 6, G 7, for Old Stile.

Examp. What's the Dominical Letter for the Year 1752?

Operat. 1752 + its $\frac{1}{4}$ (= 438) + 4 = 2194 ÷d by 7, the Remainder = 3.

Then, 7—3=4=D= Dominical Letter, or 1ſt Day of the Week Letter, E 2d &c.

To find when it is Leap Year.

Divide the Year by 4, the Remainder is the Number of Years paſt Leap Year, that is, if 1 Remains, 'tis 1 Year paſt Year, &c. if 0 Remains 'tis Leap Year.

N. B. In the Year 1752, there were 3 Dominical Letters, E, D and A; E ſerv'd from 1ſt of *January* to the 25th of *February*, D from thence to the 2d of *September*, and A from the 2d of *September* to the End of the Year.

O S Dom L— 3 = N S. D L, both change 1ſt *January*, Leap Year has 2 D L, 1ſt Serv 25 *February*, and the other to Year's End. *N. B.* Every $\frac{1}{4}$ and $\frac{1}{4}$ C is L Y, begin^{s} at 2000.

Explan. The Old Stile's Dominical Letter, — 3 is equal to the New Stile's Dominical Letter, both change the 1ſt *January.*

ary. Every Leap Year has 2 Dominical Letters, the 1ſt ſerves to the 25th of *February*, the other to the Year's End. This Rule finds the laſt; the 1ſt being the next Letter following in order of the Alphabet, and goes from A to G, &c. *Note*, Farther, that every Leap Year goes back 2 Letters, common Years but 1. And that every 100th Year is not to be accounted Leap Year, but every $\frac{1}{4}$th 100 Year is Leap Year, as well as every $\frac{1}{4}$ Year, the 1ſt $\frac{1}{4}$th Hundred Year = Year 2000.

Examp. What was the Dominical Letter New Stile, for the Year 1752?

N. B. The old Stile's Dominical Letter was D.

Operat. D = 4, Old Stile's D L, — 3 = A; New Stile's D L.

Anſ. A was the Dominical Letter New Stile for the Year 1752.

Or thus, By the Perpetual Almanac at the end of the Aſtronomical Scale; the Dominical Letter Old Stile was D, and the Old Stile ended the 2d of *September*, therefore, look under *September* for D, the old Dominical Letter; and 3 Letters upwards from it, ſtands A, which = the Dominical Letter New Stile, and againſt that Letter on the Right Hand ſtands 3, 10, 17, 24, which were the ☉ Days, or 1ſt Days of the Week in that Month, the 30th was ☽ Day or the 7th Day.

47—EP = Eſtr Lt if Ep 28 or 29 then 77— 28 or 29 Rr Eſtr Lt O S.

Explan. 47 — the Epact is Eaſter Limit; if the Epact is 28 or 29, then 77—28 or 29, the Remainder is Eaſter Limit, Old Style.

Its uſe, Is to find when Eaſter happen'd according to Old Stile.

E ☉ D, is next ☉ D, aſt E L, O Style.

Explan. Eaſter Sunday is the next Sunday after Eaſter Limit Old Style.

Examp. On what Day of the Month did Eaſter happen in the Year 1752?

Rule, Find the Epact for the Year 1752 Old Stile, (which was 25) and the Dominical Letter (which was D).

Then having found Eaſter Limit, which is 22, for 47—25 = 22, work thus.

The Letter more by 4 from Limit take,
Wat's left from neareſt 7 ſhall Eaſter make.

That is, The remainder added to Eaſter Limit is Eaſter ☉ Day, reckoning from the 1ſt of *March*.

Operat.

Operat. 4 Dominical Letter = D
+ 4

8 Letter more by 4
22 Easter Limit

14 Remainder
21 Neareſt 7 ʸ.

7 Remainder
+22 Easter Limit

29 *March*, Easter Day.

To find Easter for the Year 1758 *New Stile.*

N. B. Easter Day is the 1ſt ☉ Day, after the firſt full Moon, after the 21ſt of *March*. If the full Moon happens on ☉ Day, Easter Day is the next ☉ Day.

Firſt find the ☾ Age 21ſt of *March*, which will be 12, and the Dominical Letter which will be A, or 1; then the ☾ being 12 Days old 21ſt *March*, the 24th it will be full.

Now to find what Day of the Week the 24th of *March* will be, by the Calendar at the End of the Aſtronomical Scale.

Look for A under *March*, and againſt that ſtands 5, 12, 19, 26, which are the ☉ Days in that Month, ſo that Easter Day = 26th *March*, and the 24th = ♀.

30 : 12 Signs : : ☾ Ag : Dis ☾, à ☉.

Explan. As 30 the Days of the Moon : 12 Signs the Moon runs thro' in that time in the Ecliptic : : Age of the Moon : diſtance in Signs, that the Moon is from the Sun.

N. B. 30° = 1 Sign, and that every new ☾ is in Conjunction with the Sun; if any Eclipſe of the Sun happens, it is at that Time; and every full ☾ is in Oppoſition to the Sun, and if any Eclipſe of the Moon happens, it is at that Time.

Examp. If the Moon is ten Days old, how far is ſhe from the Sun?

Operat. { 24 } 30 ——— 10
Line, { 19 } 12 ——— 4 Signs Diſtance of ☾ from

30 — Nr Mo + — Epact, = Day Mo of N ☾.

Explan. 30 wanting the Number for the Month, and wanting the Epact, the Remainder is the Day of the Month of the new Moon.

Examp. What Day of the Month in *February* 1753 did the new ☾ happen?

Operat. 30 — 2 = N^r M^o = 28 — 25 Epact = 3 Anſ.

Note, This Rule is not exact, but near enough for common Uſe.

EP + N^r M^o + D M^o = ☾ Age: Jo, F 2, M 1, A 2, M 3, I 4, I 5, A 6, S 8, O 8, N 10, D^r 10.

Explan. Epact and Number for the Month, and Day of the Month, is equal to the Moon's Age; counting for *January* 0, *February* 2, *March*, 1, *April* 2, *May* 3, *June* 4, *July* 5, *Auguſt* 6, *September* 8, *October* 8, *November* 10, *December* 10.

Examp. 1ſt What was the ☾ Age, 24th *November* 1752?

Operat. 14 Epact + 10 N^r M^o + 24 Day Month = 48 the Z, and 48 — 30 = 18 ☾ Age.

Examp. 2d What's the Moon's Age *November* 24th, 1753?

Rule, Add 11 Days to the ☾'s Age the 24 November 1752, the Z = ☾ Age 24 N^r 1753.

Operat. 18 ☾ Age 24 N^r 1752 + 11 = 29 = ☾ Age 24th 1753.

By having the Moon's Age the 24th of *November* 1753, To find the Moon's Age the 24th of *November* 1752.

Rule, Add 19 to the ☾ Age, the 24th of *November* 1753, abating 30, the Remainder is the Moon's Age, the 24th of *November* 1752.

Operat. 29 ☾ Age, 24 *November* 1753, + 19 = 48 — 30 = 18 ☾ Age, 24th *November* 1752.

83 Line.

30 : 24 :: ☾ Age : ☾ South. Aft. N.

Explan. As 30 : 24 Hours : : ☾ Age : ☾ Southing Afternoon.

Examp. Suppoſe the ☾ Age is 18 Days, what's her Southing?

Operat. { 24 } 30 ——— 18
Line, { 19 } 24 ——— 14.4

Anſwer, The Moon south'd at 14 Hours and 4 tenths of an Hour after Noon, or 24 Minutes paſt 2 the next Morning.

Before F ☾, 60 : 48 : : ☾ Age : ☾ Shi^g after ☉ Set.

Explan. Before full Moon, As 60 : 48 : : ☾ Age : ☾ Shining after Sun's Set.

Examp. ☾ 3 Days old.

Operat. { 24 } 60 ——— 3
Line, { 19 } 48 ——— 2.24 Anſwer.

☾ Sh^g + ☉ Set^g = ☾ Set^g; and ☾ Sh^g + ☉ Ris^g = ☾ Ris^g.

Explan. Before full Moon, the Moon's Shining and Sun's Setting, is the time of the Moon's Setting; and the Sun's Riſing, and Moon's Shining is the time of her Riſing.

Examp. The 9th of *November* 1752, Suppoſe the Sun roſe at 27 Minutes after 7, and Set at 33 Minutes paſt 4; what time did the Moon Riſe, and Set, her Shining being 2 Hours, and 24 Minutes?

Operat.

Operat. 7-32 Sun's Rise | 4-28 Sun Set
+ 2-24 Moon's Shining | + 2-24 Moon Shining
9-56 Moon Risᵉ Mornᵍ | 6-52 Moon Set Evening

After F ☾ ; 60 : 48 : : 30 — ☾'s Age : ☾ Shiᵉ before ☉ Rising.

Explan. As 60 : 48 : : 30 — Moon's Age : Moon Shining before the Sun rises.

Examp. The Moon 18 Days old, what's her shining before Sun rise?

Operat. { 24 } 60——30—18=12
Line, { 19 } 48——9.36

Anſ. the Moon shines 9h 36m before Sun rise.

84 Line.

☉ Risᵉ — ☾ shᵉ bef ☾ risᵉ = ☉ rising and ☉ set — ☾ Shining = ☾ setting.

Explan. After full Moon, the Sun's rising, — Moon shining before Sun Rise, is Moon Rising. and Sun Setting. — Moon Shining, = Moon Setting.

Note, The foregoing method of finding the Moon Rising, and Setting, are not always exact ; for sometimes the Moon Rises several Night's together within an Hour's time ; therefore find the time of Moon Rising and Setting as follows, by the Instrument, which will not differ much from the true Time.

Examp. What's the time of Moon's Rising and Setting the 10th of *July*, 1753, she being 10 Days old, and her Southing 8 Hours Afternoon?

Rule, Set 10th of *July* on 43 Line, against the begining of the Moon's Age, on the 39 Line, then against 10 Days her Age on the 39 Line, stands 18° or thereabouts in ♍ ; the Sun when in 18° of ♍, rises about ½ past 7, that subtracted from 12 = 4.30 the Sun Semidiurnal Arch ; which is = to about ½ the time the Moon is above the Horizon, then the Moon's Southing, = 8 Hours, — the ½ Continuance, = Moon Rising and added is the Moon Setting.

Operat. Moon Southing 8 Afternoon
½ time above the Horⁿ 4.30
Moon Riſing 3.30 Afternoon
Moon Setting 12.30 next Morning

Examp. What's the time of ☾ Rising and Setting the 25th of *July* 1753, she being 25 Days old, and her Southing 8 next Morning.

By the Rule aforegoing on the Instrument, her Place is 5° in Gemini, the Sun rises when in that Place at 4 ; the Semidiurnal Arch is 8 Hours.

Moon Southing 8 the next Morning
— Moon ½ Continuance above the Horizon } 8

=0 ☾ Riſes, at 12 at Night and Sets next Afternoon at 4.

N. B. 'Till the full, the Moon follows the Sun having her enlightned Part next him, the Horns appearing towards the Eaſt; and after the full, ſhe goes before the Sun, and ſhines before he riſes, her enlightned Part being Eaſt, and the Horns Weſt.

☾ before full South; ☾ Southing — Hour on ☉ Dial à 12, = Hour.

Explan. Before the ☾ is full South, that is, before the Moon's Shadow comes to 12 o'Clock, the Moon's Southing — the Hours on the Sun Dial from 12 is = to the Hour.

Examp. If the Moon Souths at 9 at Night, and the Hour on the Sun Dial is 10, what's the Hour?

12	9 Moon Southing
—10 Hour on Sun Dial	—2
2 = Diſt à 12	=7 o' Clock Evening Anſ.

After: ☾ S° + H° on ☉ Dial à 12 = H

Explan. After 12, that is, if the Shadow is paſt 12 on the Dial, the Moon Southing and the Hour on the Dial from 12, = to the Hour.

Examp. If the Moon Souths at 3 in the Morning, and the Hour on the Sun Dial is 1, what's the Hour?

To 3 the Southing
Add 1 Hour on Sun Dial from 12

= 4 in the Morning

✱ R Aſs, — ☉ R Aſs, = ✱ Southing.

Explan. Star's Right Aſcenſion, — the Sun's Right Aſcenſion, is the time of Star's Southing from Noon.

Examp. Aldebaran's Right Aſcenſion 4h. 17m. Query his Southing, the Sun's Right Aſcenſion at time being 4h. 20?

Operat. 4.20 ✱ Right Aſcenſion
+24 becauſe leſs than the ☉ R A

Z 28-20
—20-10 ☉ Right Aſcenſion

8-10 Aldebaran's South in the Evening.

N. B.

N. B. When Subtraction can't be made, add 360m. or 24h. and then ſubtract.

Dialing.

R : T Eq Df : : S Gno : T Ho, Dſt à M ; for Dirt. But à Sub St. Dec.

Explan. As Radius is to the Tangent of the Equinoctial Diſtances of any hour from the Meridian, of any direct North or South plain : : Sine of the Gnomon (or Stile's height) : the Tangent of the hour Diſtances from the Meridian ; which Diſtances muſt be ſet on each ſide the hour of Twelve, on all ſuch Plains ; and the Stile muſt ſtand on the ſame hour and point to the Pole, or Poles of the World.

Note, The Equinoctial Diſtances are found by the continual Addition of 15°, and that all Dials that can be drawn, are Horizontal to ſome place or other ; and that any Dial may be ſo poſited, as to ſhew the hour in any other Latitude.

Examp. To make a Horizontal Dial for the Latitude of 51° 32′ North.

Firſt find the hour Diſtances from the Meridian by the foregoing Rule.

Which is, as Radius S 90 : Tangent of the Equinoctial Diſtances, 15° ; 30° &c : : Sine of the given Latitude, (which is the Stile's Height) : Tangent of the hour Diſtances from the Meridian.

Operat.	18	As 90	: :	51° 32′			
Line,	29	: 15	:	11 51	Hour Diſtances from the Meridian		XI.I
		: 30	:	24 20			X.II
		: 45	:	38 3			IX.III
		: 60	:	53 35			VIII.IV
		: 75	:	71 6			VII.V
		: 90	:	90			VI

Having found theſe diſtances, ſet 11° 51′ on each Side the Meridian, that on the right Hand is the hour of 11, and that on the Left the hour of 1, and ſo for the reſt.

N. B. This Dial will make an erect direct Dial in Latitude 38′ 28° South.

To make an erect, direct South Dial, in Latitude 51° 32′ *North.*

Note, This Dial is Horizontal in Latitude 38° 28′ South, becauſe the Pole of the Plain falls in the Horizon ; which is 38° 28′ below the Equinoctial, and alſo it falls in the Southern Hemiſphere, therefore, make a Horizontal Dial by the Rule aforegoing for Latitude 38° 28′, and ſet the Stile 38° 28′ above the Subſtile, and on the hour of 12 ; ſo ſhall the bottom, or end of the Stile point to the South Pole. Alſo if this Dial is

turn'd

turn'd upside down and set to face the North, it will become an erect direct North Dial, the end of the Stile pointing to the North Pole; for all Dials make their opposite, being turn'd upside down.

To make a South or North Recliner, or Incliner.

N. B. First reduce them to new Latitudes, where such Dials are Horizontal, by this

Rule, Dir S + N R^{rs} + I^{rs} red^{d}, to Hor^{l} : X Pol of Pln + Eq = New L^{t}. If Pol Pln is in Nh Hm = N L.

Explan. Direct South and North Recliners and Incliners reduc'd to Horizontals. The Difference between the Pole of the Plain and Equinoctial is the new Latitude where that Dial is Horizontal.

Note, If the Pole of the Plain falls in the Northern Hemisphere, then it is Horizontal in North Latitude, but if it falls in the Southern Hemisphere, that Dial is Horizontal in South Latitude.

Examp. Make a South Dial for Latitude 51° 32′, Reclining from the Zenith 25°.

N. B. The Pole of the Plain is 25° above the Horizon, or 13° 28′ below the Equinoctial, which, 13° 28′ is the height of the Stile, or Latitude of the Place where that Dial will be Horizontal; so that if a Horizontal Dial be made for Latitude 13° 28′, and the Stile set 13° 28′ above the Meridian, or 12 o' Clock Line, it will be a South Dial in Latitude 51° 32′, Reclining 25° from the Zenith.

If this Dial be turn'd upside down, and set to the North, 'till be a North inclining Dial, the Stile of which will point to the North; as before it did to the South: And that a South Incliner, makes a North Recliner.

To make an erect Dial, declining East or West from the South or North.

In these Plains, before the hour Distances can be calculated three things (besides the Latitude of the Place and Declination of the Plain) must be found, *viz.*

1st. The height of the Stile above the Plain.

2d. The Distance of the Substile from the Meridian.

3d. The Plain's Difference of Longitude.

Which are done by these

Rules, E^{r} Dec | R : C S L :: C S D^{n} : G | R : C T L :: S D^{n} : T Sub à M | C S L :: R :: S Sub à M : S X L^{n}.

Explan. 1st. Erect Declining. As Radius : Co-Sine of the Latitude : : Co-Sine of the Declination : Gnomon, or Stile's height.

2d.

2d. As Radius : Co-Tangent of the Latitude : Sine of the Declination : Tangent of the Subſtile Diſtance from the Meridian.

3d. As the Co-Sine of the Latitude : Radius : : Sine of the Subſtile's diſtance from the Meridian : Sine of the Plain's difference of Longitude.

Examp. Suppoſe the Plain of an erect Dial, declines from the South, towards the Weſt 30 °; in Latitude 51° 32′,

Firſt find the height of the Stile above the Plain.

Thus Line, { 18 } 90 ——— 60
{ 34 } 38.28 —— 32.36 Stile's height.

Then, find the Subſtile's Diſtance from the Meridian.

Thus Line, { 18 } 90 ——— 30
{ 29 } 38.28 —— 21.40 Subſtile's Diſt. from the Meridian.

Then, for the Plain's Difference of Longitude.

Thus Line, { 18 } 38.30 ——— 21.40
{ 34 } 90 ——— 36.25 X Longitude.

Which converted into Time, by allowing 15° for one Hour; gives 2h—6°—25′; therefore the Subſtile (which is the Meridian of the Plain) muſt ſtand between the Hours of 2 and 3.

Then, Prepare a Table of hours proper for the Plain

Thus, Againſt XII, ſet 36° 25′, the inclination of Meridians; from which ſubtract 15°, the Reſidue is 21° 25′; which place againſt XI and I, and from 21° 25′ ſubtract 15°, the Remainder is 6° 25; which place againſt X and II, and becauſe it is leſs than 15°, write Subſtile, and ſubtract 6° 25′ from 15°, there remains 8° 35′, which place againſt 9 and 3, the reſt are found by a continual Addition of 15°.

Then find the Hour Diſtances on the Plain by the firſt General Rule.

Thus Line, { 18 } 90 ——— 32.36
{ 29 } 6.25 —— 3.28 the Diſtance of the Hours (10 for the Eaſt and 2 for the Weſt Dial) from the Subſtile, &c. as in the following Table.

Hours

Hours for the East - - - West	Equinoctial Distances	Hour Distances on the Plain
V VII	68.35	53.57
VI	53.35	36.08
VII V	38.35	23.16
VIII IV	23.35	13.14
IX III	8.35	4.36
	Substile	
X II	6.25	3.28
XI I	21.25	11.56
XII	36.25	21.41
I XI	51.25	34.03
II X	66.25	51
III IX	81.25	74.21

N. B. This Dial makes 4, *viz.* A South declining West and East, the End of the Stile pointing South. A North declining West and East the end of the Stile pointing North.

To make a South Declining, Reclining Dial; which is the same as a North Declining Inclining Dial.

Note, In these Plains (besides the Latitude of the place, the Declination, Reclination or Inclination of the Plain) four things must be found, before the hours can be drawn.

1st. The Distance of the Meridian and Horizon.

2d. The Height of the Pole or Stile.

3d. The Distance of the Substile from the Meridian.

4th. The Plain's Difference of Longitude.

Which are done by these

Rules, S D^s R^s and N D^s I^s | R : T D^n : : S R^n. or I^n : C T D ∫ M + H | R : S D ∫ M + H : : C S R^n : $\frac{1}{4}$ S | X Lat P + $\frac{1}{4}$ S = $\frac{1}{5}$ Sine | S D ∫ M + H : $\frac{1}{5}$ S : : C S D^n : Gn | C T D^n : $\frac{1}{4}$ Si : T G : S Sub à M | $\frac{1}{5}$ S : R : : S Sub D ∫ à M : Si, X Long.

Explan. South Declining Reclining, and North Declining Inclining. As Radius : Tangent of the Declination : : Sine of the Reclination or Inclination : Co-Tangent of the Distance of the Meridian and Horizon.

2d. As Radius : the Sine of the Distance of the Meridian from the Horizon : : the Co-Sine of the Reclination : $\frac{1}{4}$ Sine.

3d. The Difference of the Latitude of the Place and the $\frac{1}{4}$ Sine = $\frac{1}{5}$ Sine.

4th. As the Sine of the Distance of the Meridian from the Horizon : $\frac{1}{5}$ Sine : : the Co-Sine of the Declination : Gnomon, or Stile's height.

5th.

5th. As the Co-Tangent of the Declination : $\frac{1}{4}$ Sine : : Tangent of the Stile's height : Sine Subſtile's Diſtance from the Meridian.

6th. As the $\frac{1}{5}$ Sine : Rad : : the Sine of the Subſtile's diſtance from the Meridian : Sine of the difference of Longitude.

Examp. A South Plain declining Eaſtward 30°, and reclining 55° in Latitude 51° 32′.

For the Diſtance of the Meridian and Horizon.

Operat. { 18 } 90——55° Reclination,
Line, { 29 } 30——25.19′ = Diſt. of the Merid^{n} and Hoz^{n}.

For the Stile's Height.

Operat. { 18 } 90——35 Co-Sine of the Reclination,
Line, { 34 } 64.41——31.14′ = $\frac{1}{4}$ Sine.

The Difference between the Latitude and $\frac{1}{4}$ *Sine* = $\frac{1}{5}$ Sine.

51.32 Latitude — 31.14, $\frac{1}{4}$ Sine = 20.18 = $\frac{1}{5}$ Sine.

Then { 18 } 64.41——60
Line, { 34 } 20.18——19.25 Stile's height.

For the Subſtile's Diſtance.

Operat. { 17 } 60——19.25
Line, { 34 } 31.14—— 6.3′ Subſtile's Diſt.

N. B. In working this the 1ſt Extream T 60 goes off the Slide, which muſt be remedi'd thus, bring Tangent 45 on the Slide, to S 31.14, the 2d term on the Stock, then againſt T 60, which is the ſame as T 30, make a Dot on the Sine Line on the Stock; then bring T 45 againſt that Dot, and againſt Tangent 19° 25′ is the S of 6° 3′ the Subſtile's Diſtance.

For the Plain's Diff Long.

Operat. { 18 } $\frac{1}{5}$ S 20.18——6° 3′
Line, { 34 } 90——17.38 Diff Long.

To find the Hour Diſtances on the Plain, by the general Analogy.

Operat. { 18 } 90——13.49
Line, { 29 } 76.8——44.3 the Diſtance of the Hour V and VII, from the Subſtile; and ſo of the reſt, as in the following Table.

Hours East	Hours West	Equinoctial Distances D M	Hour Dist. à Sub. D M
V	VII	87.22	82.07
	VI	72.22	46.17
VII	V	57.22	27.26
VIII	IV	42.22	16.52
IX	III	27.22	9.46
X	II	12.22	4.10
		Substile	
XI	I	2.38	0.53
	XII	17.38	6.02
I	XI	32.38	12.01
II	X	47.38	20.01
III	IX	62.38	32.42
IV	VIII	77.38	56.35

Set the Plain's Difference of Longitude againſt XII, and from it ſubtract 15, there remains 2.38, And as it is leſs than 15, ſubtract it from 15, there remains 12.22, then by a continual Addition of 15 &c. the reſt are found.

This Dial makes 4, *viz.* A South Declining { Eaſtward / Weſtward } Reclining 55°; and their Oppoſites being turn'd upſide down, *viz.* a North Declining { Eaſtward / Weſtward } Inclining 55°

To make a North Dial, reclining 16°, and declining 60° Eaſtward, in the Latitude of 51d 32m North.

For the Diſtance of Meridian and Horizon.

Rule, As Rad, S 90 : T Decl : : S Recl 16° : C T of Diſt Merid and Horizon, = 25° 31′ whoſe Comp^{l} = 64° 29′; is the Diſt of the Meridian and Horizon.

Operat. { 18 } 90 ——— 16
Line, { 29 } 60 ——— 25.31 Diſtance of Mer. and Hor.

For the Stile's Height.

Rule, As S Decl 60 : Rad S 90 : : C S Diſt Merid and Horiz 25° 31′ : $\frac{1}{4}$ Sine, = 29.50

Operat. { 18 } 60 ——— 25.31
Line, { 34 } 90 ——— 29.50 $\frac{1}{4}$ Sine

$\frac{1}{4}$ Sine	29.50
+ Co-Lat	38.28
$\frac{1}{5}$ Sine	68.18

Then, As $\frac{1}{4}$ Sine : $\frac{1}{5}$ Sine : : Sine Rec^{n} 16 : S Stile's height 30° 59′.

Operat.

Operat. Line, { 18 } 29.50——16
{ 34 } 68.18——30.59 Stile's height.

For the Subſtile's Diſtance.

Rule, As T Recl 16° : CS Diſt Merid and Horiz 25° 31′ : : T Stile's height 30° 59′ : Sine of the Subſtile's Diſt 64° 26′.

Operat. Line, { 29 } 16——30
{ 18 } 25.31——64.26 Subſtile's Diſtance.

For the Plain's Diff Long, or Incl of Merid.

Rule, As S. Stile's height 30.29 : T 64.26 Subſtile's Diſt à Merid : : Rad S 90 : T Incl Merid 76.10.

Operat. Line, { 18 } 30.29——90
{ 29 } 64.26——76.10

The Table.

Hours West — —East	Equinoctial Diſtances	Hour Diſtances from the Subſt.
I. XI	88.50	87.44
II. X	73.50	60.37
III. IX	58.50	40.24
IV. VIII	43.50	26.18
V. VII	28.50	15.49
VI	13.50	7.13
	Subſtile	
VII. V	1.10	0.36
VIII. IV	16.10	8.29
IX. III	31.10	17.18
X. II	46.10	28.12
XI. I	61.10	43.05
XII	76.10	64.26

Then prepare a Table as before directed. The Hour Diſtances are all calculated by the general Analogy, *viz.* As Rad S 90 : Tangent of the ſeveral Equinoctial Diſtances : : S Stile's Heig. : T of their Reſpective hour Diſtances as in the Table above.

To make an Erect, Direct Eaſt and Weſt Dial.

N. B. The eaſieſt method to make theſe Dials, is to aſſign any convenient height for the Stile; which may very well be about the 3d or 4th Part of the width of the Plain: then the hours are found by the 1ſt principal Canon, *viz.* As Radius = Tangent 45 : Stile's height in Inches : : Tangent of the Equinoctial Diſtances : hour Diſtances in Inches from the Subſtile.

The Subſtile is the hour of VI, the height of the Stile is equal to the Width from the hour of 6 to 9. This Eaſt Dial, by transferring the hours the contrary way, makes a Weſt

Dial, by calling the hour of XI, in the East Dial, the hour of 1 in the West, &c.

To make an East reclining Dial.

Examp. In Latitude 51° 32m North, make an East Dial, reclining 20°.

Reduce it to a South Decliner, by this

Rule, E + W R^r + I^r = S Dec^r | 90 — O L, = N L. | 90 — R^n or I^n = N Dec^n.

Explan. East and West Recliners and Incliners, are Erect South Decliners. Thus 90 — old Lat is equal to the new Latitude. 90 — the Reclination or Inclination, is equal to the New Declination; so that if an Erect South Dial, for Lat 38° 28′ is made Declining 70° East or West, as before in South Decliners; 'twill be an East Dial, Reclining 20°, in Lat 51° 32′. *N. B.* This Dial makes 4, *viz.* an East Reclining 20 Degrees, and a West Inclining 20 Degrees, by turning the Plain upside down.

N. B. In these Dials, the Meridian, or hour of XII, is Parallel to the Horizon; the North Pole is elevated above the East and West recliners, as is the South Pole above the opposite Incliners.

The use of the QUADRANT, *in taking an Observation.*

1st Rectify it thus, Put the thin Slide, which has on one Side the Lines 59, 60, 61, 62, (it's brass Tongue being out) into that Side, where the 58th Line is; and put the Tongue into the Notch, by the Letter A, which is in one of the brass Pieces that hold the Instrument together; then put the other Slide (it's Tongue being out) into the other end of the same Side, so as that it's end may touch the 1st Slide, and set the brass Tongue into the Notch, by the other Letter A, and it's

End into the End of the other Tongue next take the screw and screw it into the Hole or Center of the Quadrant which is in the 61 Line then Screw the plumet which is in the End of the Brass drawer On the Index and hang the Index on Screw which is in the Centre of the Quadrant

Center of the Quadrant.

The brass Drawer being out of the Octagonal Slide, the Slide still remaining in the Stock, and the brass Head on the Octagonal Slide, at the right Hand of the Instrument; then is the Instrument fit for use. *N. B.* In the said Head, are 2 small brass Slides, each containing a small piece of red or dark Glass,

Glaſs, one not ſo dark as the other; to prevent the Sun's Beams hurting the Eye in time of obſervation; to be uſed ſeperately or together, in caſe the Sun be over bright, and both may be drawn out, when the Sun can hardly be ſeen; under thoſe Slides is an object Glaſs, which may remain in, or be taken out at Pleaſure; all which Directions are to be manag'd according to the Diſcretion of the Obſerver.

To take the Sun's Altitude.

Hold the Inſtrument up to the Sun, and look through the ſight Hole, at the end of the braſs Head; directly at the Sun's centre, which will be eaſily found, by reaſon the farther end of the octagonal Slide forms a Circle of a bright Colour, and the Sun's appearing in the midſt of it; the ~~Thread or String~~ hanging at Liberty, and ſteady by virtue of the weight of the Plummet; it will cut the Altitude on the braſs Tongue, whoſe complement is the Zenith diſtance. Allowance muſt be made for the height of the Eye above the Horizon, and for Refraction; as for Parallax it is of little or no Conſequence, being not above ~~2 Minutes and~~ a Quarter. *of a Minute*

Having found the Altitude, or Zenith Diſtance; the Latitude is found by the following Rules, but firſt obſerve.

The Latitude of a Place, is the diſtance of the Equinoctial from the Zenith, or Pole of the Horizon. If the Zenith is in the Northern Hemiſphere, the Latitude is North, and the Contrary.

If the Obſerver is in North Latitude; he will ſee, looking towards the Equator, the ⊙ and Stars aſcend from the Left hand to the Right.

But if he be in South Latitude, looking towards the Equator; the ⊙ and Stars aſcend from the Right hand towards the Left.

General Rules to find the Latitude, and of what Name.

If the object doth riſe and ſet within 24 Hours,

Rule 1ſt. Meridian Altitude and Declination of 1 Name, the Difference of the Zenith Diſtance and Declination is the Latitude.

2d. If the Declination is greater than the Zenith Diſtance, the Latitude is of the Declination's name; if leſs, the contrary.

3d. Meridian Altitude and Declination of contrary Names, the Sum of the Zenith Diſtance and Declination is the Latitude of the Declination's Name.

N. B. Meridian Altitude { South / North } is when the Sun, or Object,

Object, is to the { South'd / North'd } of the Observer.

If the Object doth not Rise and Set within 24 hours.

4th. If the Object is on the Meridian, below the Pole; the Meridian Altitude and Co-Declination is the Latitude of the same Name with the Declination.

5th. If the Object is on the Meridian above the Pole; the Difference of the Meridian Altitude and the Co-Declination is the Latitude of the same Name as the Declination.

Examp. Zenith Distance South 50°, Declination 23 South, what's the Latitude, and of what Name?

50 Zenith Distance S
23 Declination —— S } Rule 1st.

27 Latitude —— N Rule 2d.

Examp. 2. 20 Zenith Distance S
23 Declination —— S } Rule 1st.

3 Latitude —— S —Rule 2d.

Examp. 3. 20 Zenith Distance N
22 Declination —— N } Rule 1st.

2 Latitude —— N —Rule 2d.

Examp. 4. 30 Zenith Distance S
23 Declination — N } Rule 3d.

53 Latitude —— N

Examp. 5. 20 Zenith Distance N
30 Declination —— S } Rule 3d.

50 Latitude — — S

If the Object doth not rise and set within 24 *Hours.*

Examp. 1. 6 Meridian Altitude, below the Pole
70 Co-Declination —— —— N } Rule 4th.

76 Latitude —— —— —— N

Examp.

Examp. 2. 60 Meridian Altitude, above the Pole
10 Co-Declination —— N } Rule 5th
50 Latitude —— N }

Examp. 3. 20 Meridian Altitude below the Pole
29.45 Co-Star's Declination —— S
49.45 Latitude —— S

The uſe of the ſhorter TELESCOPE *and Quadrant in taking the Altitude of Stars.*

Tho' the method of finding the Latitude by the Stars is the ſame as by the Sun, yet the way of finding their Altitude, or Zenith Diſtance is ſomewhat different by the Teleſcope; for to look at the Stars thro' the ſame Piece in the braſs Head, as the Sun was ſeen thro', requires that the 2 dark Glaſſes be drawn out; becauſe, if they remain in, they'll obſtruct the Sight; therefore, to ſee the Stars through the Teleſcope, the Piece which contains the 2 dark Glaſſes muſt be taken off, and the object Glaſs in the Head of the Octagonal muſt be left on; and then, by looking through that Teleſcope (for the braſs Drawer muſt be in) the Altitude of the Star may be found, by obſerving where the Thread cuts the Quadrant; for that is the Altitude, allowing as before directed for Refraction, Height of the Eye above the Horizon; as for Parallax they have little or none: And ſo having his Meridian Altitude, or Zenith Diſtance; the Latitude of the Place is eaſily found, by knowing the Star's Declination. See Star's Declination. P. 36.

Of the VARIATION *of the Sun's Declination, Place and right Aſcenſion; in reſpect to the Difference of Longitude of Places, from the Meridian of* London.

Note, The Declination, Place, and right Aſcenſion of the Sun, are adapted to the Meridian of *London*. Therefore, if the Place or Ship, is a conſiderable number of Degrees Difference

ence of Longitude, either East, or West of *London*; the Declination, &c. as they ſtand on the Inſtrument, or in any Book for that purpoſe won't do: As, ſuppoſe the place is 15° to the Eaſtward, then it is Noon one hour ſooner there, than at *London*: If it is 15° Weſt, then it is 11 there, when it is 12 here. So that the Sun, coming to the Meridian of a Place 15° East or Weſt of *London*, can't have the ſame Declination as at *London*; the Meridian of which they are calculated for as before, and to rectify the ſame, take the following

Rule, If the Difference of Longitude is { Weſterly / Eaſterly } and the Declination increaſing; the Variation muſt be { Added to / Sub. from } the Declination on the Inſtrument, &c. but if the Declination is decreaſing it muſt be { Subtracted from / Added to } it.

Examp. Difference of Longitude 60° Weſt, ⊙ Declination increaſing, *May* the 12th 1753; what's the Declination?

Rule, As the Place is 60° Weſt of *London*, 'tis Noon at *London* 4 Hours before it is at that Place; therefore, find the Diff of Declination betwixt that Day and the next.

Then ſay, If 24h or 360°, give that Diff in Declination, what will 4h or 60° give? which added to the Declination found on the Inſtrument, &c. is the Declination at that Place; but when decreaſing the ſame is to be ſubtracted. If the Difference of Longitude be Eaſterly, take the Difference between the preſent Day and Day before; that's the Daily increaſe. Underſtand the ſame of his Place, and right Aſcenſion.

To rectify the Declination.

Declination for *London May* 13th —18°—30′
D° —— —— *May* 12 —18—15

Daily Increaſe —— —— 15

Then, If 24h or 360° give 15′ what will 4h or 60° give?

Anſwer, 2′ 30″, add this becauſe 'tis increaſing to the Declination of *May* 12, and it will be 18° 17′ 30″ which is the Declination that Day, 60° Weſt of *London*.

To

To rectify the right Aſcenſion.

Right Aſcenſion for *London May* 13 = 3h-20′
D° —— —— —— 12 = 3 -16

Daily Increaſe —— —— —— 4

Then, As 24h : 4′ : : 4h : 40″, which added to 3h 16′, makes 3h 16′ 40″, the right Aſcenſion; rectify'd to that Place.

To rectify the Sun's Place.

Sun's place for *London May* 13th = 22° - 46′
D° —— —— —— 12 = 8 21 - 49

Daily Increaſe —— —— —— 57

Then, As 24h : 57′ : : 4h : 9′ 30″, which added to his Place *May* the 12th makes 8 21° 58′ 30″, the Anſwer.

The uſe of the QUADRANT *and ſhorter Teleſcope, in taking a Diſtance at* 1 *Station.*

Examp. If the height of the Obſerver's Eye be 6 ft, and the Angle below the level of the Eye, to the bottom of the Object be 10°, what's the Diſtance from the Obſerver's Foot to the bottom of the Object?

Rule, As the Sine of the obſerv'd Angle, below the level of the Eye : Obſerver's Height, or Inſtrument above the Horizon : : Co-Sine : Diſtance 34.02 feet.

Operat. { 18 } 10 ——— 80
Line, { 24 } 6 ——— 34.02 Anſwer.

N. B. Thus any Diſtance may be found, the obſerver ſtanding on an Eminence, whoſe height is known, as a Ship's Maſt, Houſe, &c.

To take an ALTITUDE *at* 1 *Station, if the whole may be ſeen, and the bottom level with the Obſerver's Foot.*

Examp. If the ∠ from the Level of the Eye to the Bottom be 10°, and the Angle to the Top 30°, above the Eye of the Obſerver; what's the Altitude of the whole Building?

Rule, Firſt find the Diſtance from the Foot of the Obſerver, to the bottom of the Building as before; which is 34.02 ft, then ſay as the Co-Sine of the Top obſerv'd Angle, above the level of the Horizon : Diſt found as before : : Sine of the obſerved

∠ : Altitude above the Eye of the Obſerver, which is 19.64. And added to 6 Feet = 25.64 the height of the Building.

Operat. { 18 } 60——30
Line, { 34 } 34.02——19.64 + 6 = 25.64 Anſwer.

To find a Breadth at one Station.

Examp. Suppoſe the Obſerver's height be 6 Feet, the Angle from the Level of the Eye to one Extremity 20°; the other Angle 30°, what's the Breadth?

Rule, Firſt find the Diſtance from the Obſerver's Foot, to each extremity,

Thus { 18 } 20——70
Line, { 24 } 6——16.48 Diſt.
Then { 18 } 30——60
Line, { 24 } 6——10.39

So that 16.48 and 10.39 are the Diſtances from the Obſerver's Foot to the Extremities of the Breadth; then to find the Breadth, take the ∠ of the breadth, Thus, ſet the ſide of the Inſtrument on a Pin (the hole on the 61 Line, being againſt the hole on the 85 Line, ſo as that the Pin may go thro' both Holes; the Pin being in a Board prepar'd for that purpoſe) then turn the Inſtrument about, ſo as that the Extremities of the Wall &c. may be ſeen thro' the Teleſcope; draw Lines by the ſide of the Inſtrument where the Extremities are ſeen; take the Angle of the breadth with a pair of Compaſſes, and then having the ∠, and the Sides, which are the diſtances found as before from the Foot to each Extremity: The breadth may be found as follows.

Suppoſe the included ∠ be 80°, the Sides are 10.39 ft, and 16.48 ft.

Then, As Z of Sides : X of the Sides : : Tang^t of $\frac{1}{2}$ Z of 2 Op ∠'s : T $\frac{1}{2}$ Diff.

10.39	180
16.48	—80
26.87 Z Sides	100 Z of 2 Op ∠'s.
	2
6.9 X Sides.	
	50 = $\frac{1}{2}$ Z

Line,

Ope. { 6 } 26.87——6.9
Line, { 29 } 50——15.6 = ½ X

50 ½ Z of 2 ∠'s
+ 15.6 ½ X

65.6 ⌐ ∠

34.54 ⌐ ∠

Then, as either of thoſe 2 ∠'s : oppoſite Side :: ∠ of the Breadth : the Breadth.

Operat. { 18 } 34.54——80
Line, { 24 } 10.39——17.88 Anſ. Breadth 17.88 Feet.

To take an Altitude at 2 Stations, when the whole can't be ſeen.

In order to which, take the Angle to the Top, which ſuppoſe 30°: then go either towards the Object, or from it in a ſtraight Line, any Number of Feet, Yards, &c. As, ſuppoſe 30 feet back, and then the Angle to the Top be 20°; what's the Altitude of the Object?

Rule, As the Sine of the Difference of the 2 obſerv'd Angles : diſtance of the 2d Station : : Sine of the 2d obſerv'd ∠ : diſtance from the Eye at the 1ſt Station to the Top of the Building which is 59.1 ft.

Then, As Radius Sine 90 : Diſtance from the Eye at the firſt Station to the Building's Top : : Sine of the firſt obſerv'd Angle : height of the Building from the Level of the Eye, which is 29.5 and added to 6 feet, the Obſerver's height gives 35.5 ft. = Altitude of the Object.

To find the Semidiameter of the viſible Horizon.

Suppoſe the Eye of the Spectator be 6 feet above the Horizon, how far will the viſible Horizon appear to him?

Rule, The Z of the Diameter of the Earth, and height of the Obſerver's Eye above the Horizon, multiply'd by the height of the Obſerver's Eye, is equal to the Square of the Diſtance, and the Root is the Anſwer.

Suppoſe, 42078016 ft = Diameter of the Earth.

\+ 6

42078022
× 6

252468132 its $\sqrt{\ }_2$ = 15889 and ÷d by 5280 = 3 [Miles and 49 Feet.

To find how far an Object may be ſeen at Sea.

How far may an Object 60 feet high be ſeen by an Obſerver, whoſe Eye is 6 feet above the Horizon?

Rule, The method is the ſame as the foregoing, only it muſt be found at twice; firſt find how far the Obſerver can ſee as before, (his Eye being 6 feet above the Horizon) which is 3 miles 49 feet; then for the diſtance of the Object, beyond the diſtance the Eye could ſee without that Object.

42078016 ft. Diam^{r} of the Earth.

\+ 60

\-42078076

× 60

2524684560 is $\sqrt{\ }^{2}$ = 50246 Ft. (om. 2726Ft.

5280 + 3 — 49

2726 12—2775 the Ob. can be ſeen.

APPENDIX.

APPENDIX.

NUMERATION on the Line of equal Parts, or natural Numbers.

Note, THE whole Foot is divided into 100 equal Parts that is, the 10 is 10; 20 is 20 &c. if the firſt ſmall Stroke at the beginning denotes 1, the ſecond ſmall Stroke is 2; or the 1ſt ſmall Stroke at the beginning may be counted 10, then the ſecond will be 20; and the long ſtroke mark'd 10 will be 100, and ſo if the firſt Stroke is counted 100, that Stroke mark'd 10 will be 1000.

To find the Place repreſenting 15.

Count the firſt ten Strokes mark'd 10, for 10; then the Diſtance from the beginning, to five ſmall Strokes from the 10 = 15.

To find the Number 164.

Count the firſt ten, for 100; then 6 ſmall Strokes is 60, and from the ſixth ſmall Stroke to the 7th muſt be imagin'd to be divided into 10 equal Parts, take 4 of thoſe Parts, ſo the extent from the beginning to that Place, will repreſent 164.

ADDITION by natural Numbers, or equal Parts.

Examp. What's the ſum of 3 and 4?

Rule, Bring the beginning of the 51ſt Line, which may be call'd Nought, againſt 3 Strokes on the 52d Line, then againſt 4 Strokes on the 51ſt Line, ſtands 7 on the 52d Line.

Operat. Line, 51 0———4
52 3———7 Anſwer.

Examp. 2. What's the ſum of 75 and 105 and 85?

Rule, Put 0 on the 51ſt Line, to 75 on 52d Line; that is, againſt 7 ſmall Diviſions and $\frac{1}{2}$, which is equal to 5, then under

under 105, ſtands 180; ſet 180 on the Slide under 0 on the Stock, and under 85 ſtands 265.

Operat. Line, { 51 52 } 0——105 / 75——180 *Then,* { 0——85 / 180——265 Anſwer.

SUBTRACTION by the Lines of equal Parts.

Examp. From 7 take 4.

Rule, Set 4 on the 51 Line, over 7 on the 52 Line; then the Number under 0 on 51 Line, is the Anſwer on the 52 Line.

Operat. Line, { 51 52 } 0——4 / 3 Anſ.——7

MULTIPLICATION by the Lines of equal Parts.

Examp. Multiply 4 by 3.

By Line the 6th, the Anſwer is 12, and by the Lines of equal Parts this is the

Method, Set 0 on the 51ſt Line, againſt 4 on the 52d Line; then againſt 4 on the 51ſt Line, ſtands 8 on the 52d Line; and againſt 8 on the 51ſt Line, ſtands 12 on the 52d Line. Hereby it appears that Multiplication is a compendium of Addition.

Operat. Line, { 51 52 } 0——4——8 / 4——8——12 Anſwer.

DIVISION by the Lines of equal Parts.

Examp. Divide 12 by 4.

Rule, Set 4 on the 52d Line, againſt 0 on the 51ſt Line, then againſt 12 on the 52d Line, ſtands 8 on the 51ſt Line, and againſt 8 on the 52d Line, ſtands 4 on the 51ſt Line, and againſt 4 on the 52d Line is 0 on the 51ſt Line; therefore as there are 3 Operations the Anſwer is 3. Hereby it appears, that Diviſion is a compendium of Subtraction.

Oper. Line, { 51 52 } 0——4——8 / 4——8——12 Dividend.

Examp. 2. Divide 14 by 4.

Set

Set 4 on 52d Line, to 0 on 51ſt Line; then againſt 14 on 52d Line, ſtands 10 on 51ſt Line, againſt 10 ſtands 6, and againſt 6 ſtands 2, the Quotient is 3 and 2 the remainder, becauſe there are 3 Operations and 2 remains.

Operat. { 51 } 0——2——6——10
Line, { 52 } 4——6——10——14

Or thus, Set 4 on 52d Line, to 0 on 51ſt Line; then againſt 4 on 51ſt Line, ſtands 8 on 52d Line, and againſt 8 on 51 Line, ſtands 12 on 52d Line, and againſt 12 on 51ſt Line ſtands 16 on 52d Line, which is 2 above 14, and therefore the Quotient is 3, and remainder 2.

Operat. { 51 } 0——4——8——12
Line, { 52 } 4——8——12——16

As Multiplication and Diviſion are compendiums of Addition and Subtraction; take an Example in the Rule of Three, perform'd by Addition and Subtraction.

Examp. If 2lb. coſt 6s. what coſt 3lb?

Operat. 6 + 6 + 6 = 18; then 18 — 2 = 16 — 2 = 14 — 2 = 12 — 2 = 10 — 2 = 8 — 2 = 6 — 2 = 4 — 2 = 2 — 2 = 0.

N. B. Here 6 is added 3 times, becauſe the 3d Number is 3, and from that ſum the 1ſt Number is taken as oft as it can be, which is 9 times. Anſ. 3lb coſt 9s.

MULTIPLICATION by Logarithms.

N. B. The ſum of any 2 Logarithms = to the product of the 2 natural Numbers.

See the uſe of the 50th Line. Page 37.

Examp. What's the product of 4 multiply'd by 3?

Rule, Look for the Number 4, on Line 50, and under that ſtands 602, the Log. thereof on Line 51; alſo againſt 3 on Line 50, is 477, the Log thereof; their ſum is 1.079. Look for 079 (rejecting the Index) on Line 51, and over it on Line 50, are 2 grand Diviſions from the beginning; *Note,* the Index or Characteriſtic being 1, it ſhews that the Number ſought is ſo much above 10 which = 12; if the Index had been 2 then thoſe 2 grand Diviſion would have been 20 above 100.

Operat. 4 its Log .602
3 D° .477
12 —— 1.079

DIVISION by Logarithms.

Note, The Difference of any 2 Log is equal to the Quotient.

Examp. Divide 9 by 3.

Rule, Find the Logarithms as before, the Difference is the Anſwer.

Ope. Dividend 9 its Log is .954
Diviſor 3 .477
Quotient 3 .477

Look for .477 on Line 51 and over that on Line 50 is 3, the Anſwer.

REDUCTION by Logarithms.

Examp. In 5 l. how many Pence?

Rule, The Sum of the Logarithms of 5, 20 and 12 is the Anſwer, becauſe Pounds multiply'd by 20 = Shillings, and Shillings multiply'd by 12 = Pence.

Operat.

5	.699 ferè	Look for .079 on the
20 Log =	1.301	51ſt Line, and over that
12	1.079	ſtands 2; the Index be-
		ing 3, therefore the Num-
Pence 1200	3.079	ber is between 1000 and
		10000, the Anſ. is =
		1200.

Examp. 2. In 1200 d. how many Pounds?

Rule, The ſum of the Log of 12 and 20, ſubtracted from the Log of the Pence; the remainder = Log of the Anſwer, becauſe, as before, the difference of the Log = the Quotient of the natural Numbers.

Operat.

1200 ——— 3.079
12 ——— 1.079
20 ——— 1.301
Sum of the Log - - - - 2.380
Anſwer 5 l. Remainder - - - .699 ferè

N. B. The Log of 5 is .69897, but the Anſwer .699 is as near as can be done by the Inſtrument.

Examp. 3. In 9 Guineas how many Moidores?

Rule, Add the Log of the Guineas, and Log of the Shillings in 1 Guinea together; ſubtract the Log of the Shillings in a Moidore therefrom, the remainder is the Anſwer in Moidores.

Operat.

Operat. Shill. 21 —— 1.322
Guin. 9 —— .954

Z 2.276
Log of 1 Moid. or 27 s. —— 1.431

Moidores 7 ===== .845 Anſwer.

The Rule of THREE by Logarithms

Is work'd in the ſame manner as the laſt Example in Reduction.

Examp. If 2lb coſt 12s. what coſt 6 lb?

Operat.	2 ——	0.301
	12 ——	1.079
	6 ——	0.778
	Sum ——	1.857
	Rem^{r} 36d. ——	1.556 Anſwer.

Or, If 2 Pounds coſt 1s. what coſt 6 Pounds?

Operat.	2—	.301
	1—	.000
	6—	.778
	Sum	.778

Rem^{r} 3 = .477 Anſwer 3 Shillings.

SQUARE Root by Logarithms.

Examp. What's the Square Root of 4?

Rule, Divide the Log of the Number by 2, the Quotient is the Log of the Anſwer.

Operat. 4 Nr. —— .602
÷ 2

Anſwer 2 —— .301

To find the CUBE Root by Logarithms.

Rule, Divide the Log of the Number by 3, the Quotient is the Anſwer, if for the Biquadrate by 4, for the 5th Power by 5 &c.

Examp. What's the Cube Root of 27?

Operat. 27 Nr = 1.431 ÷ by 3 = .477 = 3 Anſwer.

The uſe of the ſingle Line of Numbers, or equal Parts on the SECTOR.

Example in MULTIPLICATION.

Multiply 3 by 2.

Rule, Take the extent from the Center to 1 on the Line mark'd L, and ſet it acroſs from 3 to 3 on the Lines L; then take the extent from the Center to 2, and that will reach acroſs from 6 to 6, the Anſwer.

DIVISION by the Sector.

Examp. Divide 6 by 3.

Rule, Take the extent from the Center to 1, and ſet it acroſs from 3 to 3, then take the extent acroſs from 6 to 6, that extent will reach from the Center to 2, the Anſwer.

REDUCTION and the Rule of 3, by the Sector.

In 9 Guineas how many Moidores?

Rule, Take the extent from the Center to 27, lay that acroſs from 21 to 21; then take the extent from the Center to 9, that will (being laid acroſs) reach from 7 to 7, the Anſwer.

SQUARE Root by the Sector.

Rule, Take the extent of 1, from the Center, and ſet that acroſs to the imagin'd Root, then take the extent from the Center to that imagin'd Root, and ſet that acroſs from the Square Number to the ſame Square Number, and if that exactly meaſures that diſtance is the Root; if not, try again.

CUBE Root by the Sector.

Take the extent of 1, and ſet that acroſs to the imagin'd Root, then take the extent from the Center to that number or imagin'd Root and ſet that acroſs and mark what Number that reaches

reaches to, then take the extent from the Center to that laſt Number, and ſet that acroſs, and if it falls on the Cube number, the imagin'd number is the Cube Root.

To ÷ a Line into any number of equal Parts, as ſuppoſe into 7; Take the extent in the Compaſſes, and ſet that from 7 to 7; then the extent from 1 to 1 is the $\frac{1}{7}$ Part.

The uſe of the SINICAL QUADRANT *in Multiplication, &c.*

Examp. Multiply 4 by 3.

Rule, Set 1 of the Beads on the String facing 1, and under 4; then ſet the other Bead facing 3, and it will ſtand under the Anſwer 12.

DIVISION by the Sinical Quad.

Examp. Divide 12 by 4.

Rule, Set 1 of the Beads on the Sring under 4, and facing 1; then ſet the other Bead under 12, and it will ſtand againſt 3, the Anſwer.

REDUCTION by the Sinical Quad.

In 9 Guineas how many Moidores?

Rule, Facing 27, the Shillings in a Moidore on the Side, and under 21, the Shillings in a Guinea, on the Top; bring 1 of the Beads, then ſet the other Bead facing 9, the Guineas; and it will ſtand under 7, the Moidore's Anſwer.

The Rule of Three by the Sinical Quad.

Examp. If 2 Yards coſt 17 s. what coſt 8 Yards?

Rule, Set 1 of the Beads to face 2, and under 17; then ſet the other Bead to face 8, and it will ſtand under 68 the Anſwer.

Square Root by the Sinical Quad.

Examp. What's the Square Root of 4?

Rule, Set 1 of the Beads under the imagin'd Root, and facing 1 on the Side; then ſet the other Bead facing the ſaid imagin'd Root, and if it ſtands under the Square Number; that imagin'd Root is the Anſwer, which is 2.

Cube Root by the Sinical Quad.

Examp. What's the Cube Root of 8?

Rule, Set 1 of the Beads under the imagin'd Root, and facing 1; then ſet another facing the imagin'd Root, and it will ſtand

under the Square of the imagin'd Root; alſo, ſet the other Bead under the Cube, and if that Bead ſtands againſt the Square number on the Side, the imagin'd Root is right; if not, try again; the Anſwer is 2.

The uſe of the Sinical Quadrant in working Day's work in PLAIN *and* MERCATOR'S *Sailing.*

N. B. This Quadrant may very eaſily be made on ſtiff Paper; thus, deſcribe a quarter of a Circle and divide the Arch Part into 90 Degrees, = a Quadrant; alſo into 8 Parts, &c. which are the Rumbs, then divide the Sides into an 100 equal Parts, and draw Lines Parallel to the Sides ſo that the Quadrant may be full of ſmall Squares, &c.

At the Center faſten a Thread, let there be 2 or 3 ſmall Beads on the Thread (or Pin's Heads will do) ſo as they may be mov'd eaſily; but muſt be ſo tight on the Thread as to ſtand where they are plac'd.

Note, In the following Operations, one Side muſt always ſtand North and South; the Center being at the Top in Sailing Southerly but downwards; if Sailing Northerly, if Sailing Weſterly, the Arch muſt ſtand to the Left, if Eaſterly, to the Right.

Exampl. Co SSW, Diſt 40, what's the Diff Lat and Departure?

Operat. Set the Bead to the diſtance 40, (being meaſur'd on the Side of the Quadrant) then lay the Thread over 2 Points from the Side of the Quadrant, then will the ſaid Bead ſtand againſt 36.9 ferè the Diff of Lat, and under the Departure 15.3.

Examp. 2. Co SSW, and Diff Lat 36.9, what's the Diſtance and Departure?

Operat. Lay the Thread over the Courſe, 2 Points; and ſet the Bead facing the Diff Latitude 36.9 on the Side of the Quadrant, then will the Bead ſtand under 15.3, the Departure and it will cut 40 the Diſtance, being brought to the Side.

Examp. 3. Co SSW, Dep 15.3; what's the Diſtance, and Diff Lat?

Operat. Lay the Thread over the Courſe, 2 Points, and ſet the Bead under 15.3 the Departure; then it will face 30.9, the Diff Lat, and being brought to the Side, the Diſtance is 40.

Examp. 4. Diſt 40, Diff Lat 38.9, what's the Co and Departure?

Operat. Bring the Thread to the Side of the Quadrrnt, and ſet the Bead to 40 the Diſtance; then move the Thread, ſo that the Bead may ſtand againſt 36.9, the Diff Lat; then will the

the Bead ſtand under the Departure 15.3, and the Thread will cut the Courſe, 2 Points in the Arch.

Examp. 5. Diſt 40, Departure 15.3, what's the Co and Diff Latitude?

Operat. Set the Bead to the Diſtance 40, move the Thread ſo that the Bead may ſtand under the Departure 15.3; then it faces the difference of Latitude 36.9, and the Thread lays over the Courſe 2 Points.

Examp. 6. Diff Lat 36.9, Dep 15.3, what's the Courſe and Diſtance?

Operat. Move the Thread and Bead, ſo that the Bead may ſtand under the Dep 15.3, and to face the Diff Lat 36.9; then will the Thread lay over the Courſe 2 Points, and bringing the Thread to the Side of the Quadrant, the Bead will cut 40, the diſtance.

Mercator's Sailing by the Sinical Quad.

Examp. Diff Lat 36.9, Merid Diff Lat 50, Diff Long 20.73 what's the Courſe, Departure and Diſtance?

Operat. Set 1 of the Beads to face 50 the Meridional Diff Lat, and to ſtand under the Diff of Long 20.73; then ſet the other Bead againſt the true Diff of Lat 36.9, the Thread will lay over the Courſe SSW, and the 2d Bread will ſtand under the Departure 15.3; and being brought to either Side, it will ſtand at 40, the Diſtance.

Examp. 2. Co SSW, Diſt 40, what's the Diff of Long.

Operat. Find the Diff of Lat as before, which is 36.9 and from thence the Mer^{l} Diff of Latitude; which ſuppoſe is 50, then lay the Thread over 2 Points, and ſet the Bead to face the Meridional Diff of Latitude, and it will ſtand under the Diff of Long 20.7.

Examp. 3. Diff Lat 36.9, Meridi^{l} Diff of Lat 50, Courſe SSW, what's the Diſtance and Diff of Long?

Operat. Lay the Thread over 2 Points, and ſet the Beads facing both the Differences of Latitude; the one will ſtand under 20.7 the Diff of Long, and the other brought to the Side will be 40, the Diſtance.

Examp. 4. Diff Lat 36.9, Meridional Diff of Lat 50, Diſtance 40, what's the Courſe and Diff of Long?

Operat. Set one of the Beads to 40, and the Thread, ſo that the ſaid Bead may face 36.9 the Diff of Lat; then will the Thread lay over 2 Points the Courſe; then ſet the other Bead facing 50 the Meridional Diff of Lat, and it will ſtand under the Difference of Longitude 20.7.

Examp.

Examp. 5. Diff of Lat 36.9, Departure 15.3, Meridional Diff of Latitude 50; what's the Course, Distances, and Diff of Long?

Operat. Set the Thread so, that 1 of the Beads may stand under the Departure and facing the Diff of Lat; then set the other Bead facing the Meridional Diff of Lat, and it will stand under the Diff of Longitude; the Thread will lay over the Course = SSW, then bringing the Thread to one of the Sides, the Distance is found by the 1st Bead to be 40.

Examp. 6. Course SSW, Departure 15.3, what's the Distance, Diff Lat, and Diff Long?

Operat. Set the Thread over the Course, and one of the Beads under the departure; then, against that Bead stands the Difference of Lat 36.9, by which may be found the Meridional Diff of Latitude, suppose 'tis 50, then set the 2d Bead facing the said 50, and it will stand under 20.7; the Difference of Longitude; and the 1st Bead being brought to either side, will cut the Distance 40.

Examp. 7. Dist 40, Departure 15.3, what's the Course, Diff of Lat and Diff of Longitude?

Operat. Set one of the Beads to the Distance, and bring it under the Dep 15.3; then the Thread will lay over 2 Points, the Course, and the Bead will face 36.9; the Diff Latitude; thereby find the Meridional Diff Lat; which suppose 50; then set the other Bead to face that 50, and it will stand under 20.7 the Diff Longitude.

Examp. 8. Co SSW, Diff Long 20.7. from Lat 50°; what's the Dist and Diff of Latitude?

Operat. Lay the Thread over 2 Points, the Course; and set the Bead under the Diff Long, and it will face 50, the Merid Diff Lat.

The Merid Parts for Latitude	50° is	3475
Subtract the Merid Diff Lat		50
The Remainder is		3425

Answerable thereto is 49.28 the Lat come into, so that the Diff Lat is = 32 Minutes.

The Distance is found as in the 2d Example of Plain Sailing.

MULTIPLICATION on the Line of Artificial Numbers with Compasses.

Examp. What's the Product of 4 multiplied by 3?

Rule, The Extent from 1 to 4 will reach from 3 to 12 the Answer.

DIVISION,

DIVISION with Compaſſes.

Examp. Divide 12 by 2.

Rule, The Extent from 3 to 1 will reach from 12, to the Anſwer.

REDUCTION with Compaſſes.

Examp. In 5s. how many Pence?

Rule, The Extent from 1 to 5, will reach from 12 to 60, the Anſwer.

Rule of THREE with Compaſſes.

Examp. If 2 Pounds coſt 6s. what coſt 3 Pounds?

Rule, The extent from 2 to 6, will reach from 3 to 9, the Anſwer.

Square ROOT with Compaſſes.

Examp. What's the Square Root of 9?

Rule, Take the middle between 1 and 9, that extent meaſur'd from 1, is the Anſwer, which is 3.

Cube ROOT with Compaſſes.

Examp. What's the Cube Root of 27?

Rule, Take the $\frac{1}{3}$ Part from 1 to 27, that meaſur'd from 1, is the Anſwer.

Another way of MULTIPLICATION, *&c. by the Line of Equal Parts.*

Examp. Multiply 3 by 2?

Method, From the Scale of equal Parts, or Foot Meaſure, take the Diſtance of 1; at that Diſtance ſet off 3, either at right ∠ or any other way; it matters not, then from the beginning of the firſt Line, draw an Hypotenuſe Line, to cut the extremity of the Line 3, then at the extent of 2, laid on the firſt Line, draw a Line parallel to the Line 3, till it cuts the Hypotenuſe Line aforeſaid, ſo ſhall this laſt Line be the Anſwer, which is 6, this Method is the ſame in *Diviſion*, *Reduction*, *&c.*

Some few Uſes of the Inſtrument, in the Art of Rope-making.

To find the Number of Threads on each Hook.

Examp. If a $\left\{\begin{matrix}3\\6\end{matrix}\right\}$ Inch $\left\{\begin{matrix}\text{Shroud}\\\text{Cable}\end{matrix}\right\}$ laid Rope, has 20 Threads

Threads per Hook, how many Threads per Hook, for a { 6 / 12 } Inch { Shroud / Cable } laid Rope?

Rule, As the Size on the Root Line: Threads on the Square Line:: Size on Root: Threads on the Square.

Operat. Line, { 31 / 24 } { 3—6 / 20—80 } Shroud { Line { 31 / 24 } { 6—12 / 20—80 } Cable.

N. B. 12 goes off the Rule, therefore, obſerve what N^{r} 10 ſtands againſt, which is 55.5, then bring the firſt one = 10 againſt that 55.5, and againſt 12 ſtands 80.

Work after the ſame manner for any Size of Yarn, as ſuppoſe, 16 Thread Yarn, ſay as 3, or 6 on the Root: 16 on the Square &c.

To find what Length of Cable, any Fathoms of Yarn will produce.

Examp. If 200 Fathoms of Yarn produce 120 Fathom of Cable, how many Fathom of Cable, will 150 Fathom of Yarn produce?

Rule, As 200 on the Square Line: 120 on the Square Line:: 150: Anſwer.

Operat. Line, { 6 / 24 } 200——150 / 120——90 Anſwer.

The Reverſe

Finds at what Length Yarn muſt be ſet, to produce any Length of Cable.

Examp. If 120 Fathom of Cable, require 200 Fathom of Yarn, how many Fathom of Yarn for 90 Fathom of Cable?

Rule, As 120 on the Square Line: 200 on the Square:: 90: 150.

Operat. Line, { 6 / 24 } 120——90 / 200——150 Anſwer.

To find what Length of Rope will make an C. *wt. of any Size.*

Examp. If 486 Fathom of a 1 Inch Rope, weigh 1 C. how many Fathom of a 12 Inch Rope for 1 C. Weight?

Rule, As the Square of the Size, on the Square: 1 on the Square:: 486: Anſwer.

Operat. Line, { 6 / 24 } 144——486 / 1——3.375 Anſwer 3 F. 2 Feet 3 Inch. make 1 C. W^{t} of 12 Inch Rope.

6

——

Feet 2.250

12

——

Inches 3.000

——

N. B. By knowing how many Fathom make 1 C. W^{t} 'tis very eaſy to find the W^{t} of any N^{r} of Fathoms.

Examp.

Examp. What's the W^t of 120 Fathoms of 12 Inch Rope?

Rule, As 3.375F. : 1C. :: 120 Fathom : Weight.

Operat. { 6 } { 3.375——120
Line, { 24 } { 1——35.555 = 35C. 2qrs 6lb.

N. B. 'Tis a common Method to find the W^t of 120 Fathom of any Size, thus; the Square of $\frac{1}{2}$ the Size, they says is = W^t in C. but that's not quite Exact; for if so, the 12 Inch Rope would weigh 36 C. either by that Rule, or this; as the Size on Root : W^t on Square : : Size : W^t.

Operat. { 31 } R 6——12
Line, { 24 } □ 9 ——36 C. the Answer, which before is found to weigh 35 C. 2qrs. 6 lb. however as the Difference is not much, 'twill serve very well for common Use.

To find the Weight of any Length and Size of any Rope, by the common Method of Squaring $\frac{1}{2}$ the Size of the Weight of 120 *Fathom.*

Examp. Suppose as before, 120 Fathom of 12 Inch, weigh 36 C. what will 100 Fathom weigh?

Operat. { 24 } 120——100
Line, { 19 } 36——30 C. Answer.

To find how the Size must be increas'd, in proportion to the Strength.

Examp. If a 12 Inch Cable is capable of holding a Ship of 300 Tuns, what's the Size that's capable of holding one of 500 Tuns?

Role, As 300 on Cube : 12 on Root : : 500 : Answer.

Operat. { 7 } 300——500
Line, { 31 } 12——14.23 Answer.

To find the Tonage of the Goods.

N. B. 40 Solid Feet = 1 Tun.

Examp. A Case 8 feet Long, 2 Broad, and 2 Deep; what's the Tonage at 20s. the Ton?

Operat. 8x2x2 = 32 Solid Feet.

Then { 24 } 40——32
Line, { 19 } 20——16 Shillings Answer.

Examp. A Case 7 F. 6 In. Long, 4 F. 9 In. Broad, and 3 F. 8 In. Deep; what's the Tonage?

N. B. Against 6 on the 13th Line stands .5
And against 9—— —— —— —— .75 } on 52 Line.
And against 8—— —— —— —— .66

Operation Duodecimally.

Ft In
7 . 6
4 . 9
5 . 7 . 6
30 . 0
35 . 7 . 6 Superficiality
3 . 8
23 . 9 . 0 . 0
196 . 10 . 6
130 . 7 . 6 . 0
40
3 . 10 Anſwer 3 Tons 10 Hundred.

Decimally

$7 \cdot 5 \times 4 \cdot 75 \times 3 \cdot 66 = \frac{130 \cdot 38750}{40} = 3$ T. 25

Inſtrumentally.

Line, { 6 } 1 ——— 4.75
{ 24 } 7.5 ——— 35. 6

and

Line, { 6 } 40 ——— 3.66
{ 24 } 35.6 ——— 3.25

or thus, find a mean Proportion between the Breadth and Depth, thus,

Line, { 6 } 4.75 ——— 3.66
{ 31 } 4.75 ——— 4.16 mean Proportion

then { 31 } 6.32 = G Pt for Tun —— 4.16 mean Proportion
Line, { 19 } 7.5 ——— 3.25 or 3 T. 10 C. Anſ.

N. B. If the Caſe is wider at one End than at the other, take the meaſure in the middle, if it is Round, Square the Dr, and Xy by the Depth; then ſay, As 14 : 11 :: Square meaſure : O meaſure.

To find the Tonage of a Ship.

N. B. There are ſeveral Methods to do the ſame, take this ſhort one.

Rule,

Rule, X^y the Length of the Keel, Breadth of the Beam, and Depth of the Hold together, and ÷ by 95 for Merchant Ships, and by 100 for Men of War.

By having the Tonage and Dimenſions of 1 Ship, to find the Dimenſions of another of any Tonage, of the ſame Shape.

Rule, As the Tonage of 1 Ship on the Cube: ſeveral Dimenſions on the Root:: Tonage of the other Ship on the Cube: Dimenſions on the Root.

Land Meaſure.

Land is meaſur'd by the Acre, each containing 160 Square Rodds (each Rodd 5 Yds ½ in Length, and 5 Yds ½ in Breadth = 30 Square Yds ¼) or 10 Square Chains, each Chain 4 Rodds Long, and 4 Rodds Broad, = 16 Square Rodds: if the Superficial Content is taken in Rodds, ÷ 'em by 160; if in Chains by 10, if in Yards by 4840; if the Figure conſiſts of many Sides, reduce it into Triangles; the Area of thoſe Triangles is the Anſwer.

N, B. 27 Solid Feet make 1 Yard, or Load of Earth, ſuppoſed = 20 C W^t. or 1 Tun.

Brick Work,

Is meaſur'd by the Square Rodd, = 16 Ft. ½ Long, and 16 Ft. ½ Broad, = 272 □ Ft. ¼, the ¼ is not minded, therefore, ÷ the Square Feet in a Wall &c. (the ſame being reduc'd to Brick and ½ thick) by 272, for Rodds.

Glazier's Work,

Is meaſur'd by the Square Foot, = 144 Square Inches;

Note, If a Square Foot of Glaſs is valued at a Shilling; the Square ½ Foot is worth 3d, and a Quarter 3 Farthings.

Joyners, *Painters*, *Plaiſterer*'s Work, Paving and Hangings is meaſur'd by the Square Yard of 9 Square Feet.

Flooring, Tiling, Slating, and Thatching by the Square of 100 Square Feet.

Hedging, Ditching, by the Rodd in Length.

F I N I S.